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INDEX

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The figures in parenthesis refer to page numbers of specialized monthly issues.

A

Abutments, Wing Wall Formulas (10) 80
Accounting, Cost System U. S. Army .... (114) 548
Accounting, General Contractor (118) 552
Accounts, Water Consumers' Block System of Handling .... (152) 636
Accounts, Water Consumers, Handling .... (76) 352
Aeration for removal of iron and manganese .... (43) 177
Aggregates, Concrete Surface Are Methods of Grading........ (133) 673
Aggregates, Effect of Grading on Concrete .... (91) 423
Aggregates for Proportioning Surface Area Method .... (103) 559
Aggregate Slag for Concrete........ (68) 320
Air Compressors, Lubrication of (57) 291
Air Lift for Boosting Artesian Well Flow .... (81) 357
Air Syphon Blowers for Rivet Furnaces .... (40) 222
Algae, Screen Wheel Removal..(146) 630
Alignment of Roman Roads........ (24) 456
American Association of Engineers, Chicago Salaries .... (17) 17
American Business, Construction Industry .... (142) 660
Anti-Malarial Work with Fishes (68) 274
Appraisal Railways, Cost of........ (45) 279
Arches, Curvature, Direct Design (15) 85
Architect and Building Contract (86) 418
Architect as a Business Man....(96) 428
Architect as a Citizen........ (100) 432
Architect, Contractor .... (20) 90
Architect, Constructive Criticism of .... (68) 320
Architect and His Education....(122) 578
Architect, Relation to the Engineer .... (96) 428
Architect, Structural Engineer....(20) 90
Architects, Constructive Criticism of .... (6) 76
Architects and Engineers, Co-operation .... (28) 210
Architects, Extended Recognition (47) 229
Architects' Responsibility for Contracts .... (38) 220
Architecture, Living .... (88) 420
Army Cantonments, Water Consumption in .... (26) 160
Arrowrock Dam, High Pressure Valves .... (21) 45
Artesian Well Flow, Boosting by Air Lift .... (81) 357
Asphalt Carpet Treatment, Ironing Out .... (60) 242
Assistant Surveyors, English Salaries .... (16) 448
Assistant Surveyors' Salaries........ (3) 435
Associated General Contractors, Program of .... (93) 403
Automatic Elevator Bucket Discharge .... (64) 298
Automobile, Cost of Operating....(76) 386
Automobiles, Safe Sight Distance (108) 484

B

Back to the Farm Slogan, Economic Fallacy of .... (130) 670
Back Yard Gardens, Watering....(47) 181
Bacterial County in Water and Sewage, Critical Study .... (32) 166
Ballast Gang Organization .... (74) 384
Ballast, Methods of Cleaning........ (76) 386
Ballast, Organization of Gan........ (74) 384
Bamboo Roads, Burma .... (31) 141
Bank Line Railways, Motor Trucks (24) 184
Bank Revetment, Concrete .... (43) 203
Beams, Concrete, Simple Method of Designing .... (78) 410
Bidding Prices in 1915 and 1919 on Water Supply System .... (132) 618
Bidding Prices, New York State Road Work .... (136) 596
Bidding Prices, Road Work........ (112) 488
Bids, Multiple, Illinois Road Work (108) 484
Bituminous Carpets on Concrete Roads .... (98) 474
Bituminous Macadam .... (147) 607
Bituminous Paint Coat, Experience with .... (44) 154
Bituminous Pavements, Hot Mix (139) 599
Bituminous Pavement for Motor Truck Traffic .... (61) 243
Bituminous Surfaces for Motor Truck Traffic .... (61) 243
Blade Grader Tractor Outfit, Road Grading .... (40) 242
Blasting Boulder .... (11) 59
Blasting Caps for Making Primers (112) 546
Blasting Charges, Detonation by Electricity .... (19) 67
Blasting Costs, Quarries .... (8) 56
Blasting with Electricity........ (19) 67
Blasting, Paper Tamping Bags for (47) 282
Block System of Handling Water Consumers' Accounts .... (152) 636
Blowers, Air Syphon Rivet Furnaces .... (40) 222
Blue Prints, Keeping Records of..(50) 284
Board of Commerce, Civil Engineer Appointed Secretary .... (26) 186
Board Float Finishing Concrete Pavement .... (102) 478
Board Scraper, Road Grading........ (4) 4
Boiler Plant Methods of Saving Coal .... (124) 524
Boiler Room, New Education of (98) 374
Boiler Room Pointers........ (154) 638
Boiler Water Treatment, Principles of .... (119) 519
Boilers, Management of........ (97) 373
Bombay, Hydro Electric Plant....(30) 462
Bond Issue, Municipal, Limit........ (25) 159
Bond Laws, Public Improvement..(45) 179
Bonded Indebtedness, Public Improvement American Cities .... (47) 181
Bonds, Architects' Responsibility (38) 220
Bonus System Applying to an Office .... (90) 400
Bonus System, Denver Tramway Co. .... (126) 526
Bonus System in Highway Work..(89) 341
Bonus System, Motor Truck Drivers .... (79) 331
Bonus System for Power Plants (93) 369
Books Purchased by Employees (73) 405
Booms, Design, Simple Methods... (27) 209
Booster Pumps, Quincy, Ill........ (124) 524
Boston Army Supply Warehouse, Form Work .... (98) 420
Boston Dry Dock, Concreting Plant .... (75) 385
Boulders, Blasting .... (11) 59
Brick Pavement Construction, Present Status .... (86) 338
Brick Pavement Construction, General Features of .... (103) 479
Brick Pavement, Special Types (113) 489
Brick Piers, Empirical Column Formulas .... (95) 427
Brick Prices, Common .... (81) 413
Brick, Price for 27 Years........ (99) 431
Brick Work, Breaking Up with Dynamite .... (7) 55
Bridge Construction .... (65) 247
Bridge Construction, Cost Plus Fee Contract .... (76) 408
Bridge, Home-Made, Spain........ (72) 324
Bridge at Lyons, France........ (4) 74
Bridge Inspection, Points Requiring Special Investigation .... (141) 681
Bridge Piers, Pneumatic Caissons (106) 562
Bridge Pontoon, Coblenz .... (149) 689
Bridge Pontoon, Railway .... (18) 450
Bridge Vertical Lift, Pennsylvania R. R. .... (81) 413
Bridge Work, Iowa .... (59) 241
Bridges, Cost of Painting........ (71) 323
Bridges, Highway, Maintenance and Painting .... (54) 306
Bridges, Motor Truck Traffic........ (111) 487
Bridges, Periodic Inspection of....(30) 212
British Canals, Future of........ (35) 467
British Roads, Joint Committee Report .... (21) 453
British Road and Bridge Programme .... (37) 469
Brooklyn Bridge and Pantheon... (130) 670
Bucket Discharge, Automatic Elevator .... (64) 298
Buenos Aires, Waterworks and Sewerage .... (28) 162
Buffer Employment, Public Works (41) 151
Building Blocks, Chalk Concrete.. (21) 453
Building Construction, Reinforced Concrete .... (28) 460
Building Contract and Architect....(86) 418
Building Contract of the Future....(86) 418
Building Contractor, Business Methods .... (83) 415
Building Departments, City Art Commissions .... (84) 416
Building Heights in U. S........ (63) 315
Building Materials, Transmission of Heat Through .... (10) 442
Building Regulation, Heights ....(63) 315
Building Tile, Hollow, Strength of (79) 411
Building Trades, Wage Scale, New York City .... (104) 560
Building Trades Wages .... (101) 557
Building Work and Reduced Wages (64) 315
Building Work, Uniform Specifications for .... (125) 581
Buildings, Daylight and Artificial Lighting .... (151) 691
Buildings, Lighting of .... (112) 568
Buildings, School, Standardization of Plans .... (61) 313
Buildings, Steel Mill Design........ (111) 567
Bulk Cement, Advantages of....(88) 420
Bulk Cement, Handling .... (68) 250
Bulk Plant for Handling........ (154) 694
Bulk Cement, Unloading with Power Scoop .... (40) 200
Burleson and Government Ownership of Wires .... (1) 49
Burma, Bamboo Roads .... (31) 141
Business Books, List .... (149) 673
Business Conditions, Views of Construction Industry .... (136) 654
Business Prospects for Rural Motor Express .... (142) 602

C

Cables, Hoisting, Oiling ....(149) 667
Caissons, Concrete Bridge Sub-structure .... (65) 317
Caissons, Concrete, Open Excavation Method .... (65) 317
Calaveras, Hydraulic Dam Failure (15) 29
Calcium Chloride as Dust Preventive .... (129) 589
Calcium Chloride Hastening Setting of Concrete .... (141) 601
California Highway Construction Status .... (84) 336
California Roadwork Cost ....(87) 339
Camps, Wagon, County Road......(70) 252
Canadian Engineering Societies, Salaries for Engineers ....(124) 580
Canal, Irrigation, Removal of Algae .... (146) 630
Canals, British, Future of........(35) 467
Cantonments, Water Consumption in .... (26) 160
Car, First Concrete Freight........(82) 392
Car Shortage, Motor Trucks........(14) 14
Car Wheel Coming ....(70) 380
Catch Basin Cleaning, Cost of with Orange Peel Bucket ....(30) 164
Catskill Water, Chloramine Process of Treatment .... (56) 262
Cement Bags, Dust Eliminator....(81) 391
Cement Bulk Advantages ....(88) 420
Cement Bulk Unloaded ....(40) 200
Cement Gun, Coating Mine Roofs (16) 64
Cement Gun, Wall Construction, Norfolk Army Supply Base......(118) 574
Cement, Handling Bulk ....(68) 250
Cement, Low Alumina for Tunnel Grouting .... (80) 390
Cement Plant, Municipal, Los Angeles .... (73) 385
Cement Sack Bundling Device....(121) 497
Cement Testing for Subway Lines, New York .... (126) 582
Central Station Heating ....(59) 265
Centrifugal Pumps, Horsepower Requirements .... (153) 637
Centrifugal Stucco Gun, Cost of Applying Stucco .... (46) 228
Chain of Rocks Filter Plant, Operating of ....(8) 32
Chalk Concrete Building Blocks....(21) 453
Channel Excavation on Dragline..(149) 667
Chemical Theory of Rusting ......(25) 207
Chemicals, Cost, Council Bluffs..(136) 620
Chicago Pavements, Prof. Baker..(23) 23
Chicago Street Railways, Track Standards .... (110) 544
Chimney, Wind Pressures on.....(20) 452
Chloramine Process of Treatment of Catskill Water ....(56) 262
Chloramine, Sterilizing Agent ....(90) 366
Chloramination of Catskill Water..(56) 262
Chlorination of Sewage Effluent....(24) 456
Chute for Handling Bulk Cement (68) 250
Circular Concrete Reservoirs, Leamington, Ont. ....(147) 631
City Art Commissions, Builling Departments .... (84) 416
City Fire Department, Who Should Pay Operating Expense ....(103) 503
City Government, Commission Manager Plan ....(39) 173
City Hauling, Trucks and Trailers in .... (131) 591
Cities, Income and Expenses......(27) 161
City Manager Plan ....(39) 173
City Managers' Association, Important Steps of ....(27) 137
Civil Engineers, Licensed ....(74) 326
Civil Engineers, Licensing ....(88) 340
Civil Engineer, Secretary Board of Commerce .... (26) 186
Civil Engineers, Smoke Nuisance..(50) 256
Civil and Military Engineers.......(10) 58
Cleaning Water Mains, St. Louis....(7) 31
Coal Combustion .... (96) 372
Coal Consumption, Methods for Reducing .... (96) 372
Coal, Handling with Bottomless Power Scrapers .... (121) 521
Coal and Heating ....(4) 28
Coal, Methods of Saving Boiler Plant .... (124) 524
Coal Tar Derivative Waste Products, Milwaukee Water Supply....(145) 629
Coating, Mine Roofs, Cement Gun(16) 64
Coblenz, Pontoon Bridge ....(149) 689
Cohesion of Rived Mud ....(11) 443
Colorado, Road Maintenance ......(19) 19
Coloring Walls with Cement.......(17) 449
Colors, Effect on Tensile Strength of Concrete .... (77) 409
Coming Car Wheels ....(70) 380
Commission Form Government.....(39) 173
Commission-Manager Plan ....(39) 173
Commissions, State, A New Form for .... (26) 160
Common Labor, Will Wages Rise? (125) 585
Compass Used in Preliminary Railway Surveying .... (42) 202
Compensation Recommended by American Association of Engineers .... (26) 208
Compressed Air, Construction Work .... (46) 280
Compressed Air Plant, Contracting (59) 293
Concrete Arch Dam, East Canyon Creek .... (139) 623
Concrete Bank Revetment ....(43) 203
Concrete Base, Smooth Top.......(41) 141
Concrete Bases, California Experiences .... (117) 493
Concrete Beams, Simple Method of Designing .... (48) 404
Concrete, Breaking Up with Dynamite .... (112) 568
Concrete Bridges, Cost of Forms..(60) 312
Concrete Caissons for Bridge Substructure .... (65) 317
Concrete Computation, Time Saving Diagram for ....(104) 560
Concrete, Depositing Under Water (55) 307
Concrete, Effect of Colors on Tensile Strength ....(77) 409
Concrete, Effect of Mixing Water on .... (57) 309
Concrete, Effect of Vibration on....(33) 465
Concrete Freight Car ....(82) 392
Concrete, Increase in Strength by Rodding .... (109) 543
Concrete Oil Storage Tanks, Design .... (52) 304
Concrete Machine for Road Work..(17) 449
Concrete Materials, Labor Saving Equipment for ....(120) 496
Concrete, Mixing and Curing Conditions .... (57) 309
Concrete Mixtures, Design of......(89) 421
Concrete Mixing Plant, Miami Conservancy District ....(106) 540
Concrete Mixtures, Investigation at Lewis Institute ....(89) 421
Concrete Pavements, Finishing Methods for ....(76) 328
Concrete Pavement Finishing with Board Float ....(102) 478
Concrete Pavement Joints, Straight Edge .... (53) 235
Concrete, Railway Track Construction .... (93) 403
Concrete Roads, Bituminous Carpets on .... (98) 474
Concrete Roads, Illinois Specifications .... (101) 477
Concrete Roads, Labor Saving Equipment .... (120) 496
Concrete Roads, Machine Finishing .... (115) 491
Concrete Roads, Reinforcing System .... (17) 449
Concrete Roads, Rolling ....(30) 140
Concrete, Setting ....(14) 446
Concrete, Sewer, Cost, Ottawa....(38) 172
Concrete Ships, Economic Size....(31) 463
Concrete, Slag for Aggregate....(68) 320
Concrete, Temperature Records of (7) 55
Concrete, Temperature Records...(42) 202
Concrete, Temperature Variations (12) 36
Concrete Testing for Subway....(126) 582
Concrete, Tests with Calcium Chloride in Hastening Setting ....(141) 601
Concrete Wall Design, Conditions for Economy .... (44) 226
Concreting Plant, Boston Drydock (75) 385
Concreting Plant for Small Yardage Jobs .... (153) 693
Concreting, Winter, Heating Water (15) 63
Conductorettes, Street Car Unions (124) 642
Conduit, Water, Economical Section for .... (108) 508
Congress, Economic Ignoramuses in .... (102) 558
Connecticut Method of Snow Removal .... (69) 251
Connection of Street Systems to Highways .... (67) 249
Construction Camps, Ration List (52) 286
Construction Company and Engineer (2) 72
Construction Division, Army Cost Accounting System ....(114) 548
Construction Equipment, Portable Shops for Repair ....(70) 380
Construction Industry in American Business .... (142) 660
Construction Industry Views on Business Conditions ....(136) 654
Construction Labor, Probable Wages .... (50) 284
Construction Work, Compressed Air .... (46) 280
Constructive Legislation and Engineering Societies ....(51) 303
Contour Method of Relocating Roads .... (117) 493
Continuous Education, Industrial Slogan .... (97) 531
Contract Building, Future ....(86) 418
Contract, Unit Price vs. Percentage .... (132) 650
Contract Prices, State Highway, Texas .... (64) 246
Contracting Business, Salesmanship in .... (127) 583
Contracting, Compressed Air Plant (59) 293
Contractor and Architect ....(20) 90
Contractor, Building, Business Methods .... (83) 415
Contractor, General, Accounting for .... (118) 552
Contractor, Road, Overhead Expense .... (43) 153
Contractors, Building, Licensing (128) 584
Contractors and Bonding Companies .... (123) 499
Contractors and Cut-Throat Competition .... (74) 326
Contractors, Highway, Cost Keeping .... (52) 234
Contractors' Organizations, What They Can Accomplish ....(85) 395
Contractors, Relation to Engineers (63) 297
Contracts, Cost-Plus .... (92) 344
Contracts, Cost-Plus-Fee ....(87) 419
Contracts, Highway, Competency of Contractor .... (56) 238
Contracts, Methods for Highway Work .... (54) 236
Contracts, Reconstruction Period (54) 236
Contracts, Architects' Responsibility For .... (38) 220
Contracts, Unit Price ....(92) 344
Control System, Maine ....(9) 9
Convict Labor on Highway Work (93) 345
Convict Labor, Practice of Various States .... (93) 345
Convict Labor, State Highway Work, California .... (80) 332
Convict Labor, West Virginia ....(14) 14
Copper Mountain Mining Tunnel, Cost .... (52) 286
Core Drilling Outfit, Pavements Test .... (89) 341
Cost Accounting, Gravel Producers (13) 61
Cost Accounting, Sand and Stone Production .... (119) 553
Cost Concrete Arch East Canyon Creek .... (139) 623
Cost Counting System of Construction Division, U. S. Army .....(114) 548
Cost Keeping for Highway Contractors .... (52) 234
Cost Plus Contracts, Railway Construction .... (105) 539
Cost Plus Fee Contract............(76) 408
Cost, Road Work, Alabama.......(19) 19
Cost of War, Errors in Estimating (2) 26
Costs, Blasting American Quarries (8) 56
Costs of Removing Stump ....(101) 535
Costs of Small Houses............(152) 692
Costs, Thawing Water Services....(5) 29
County Road Construction, Inspection of .... (65) 247
Cradock, Va., Housing Developments .... (4) 52
Crane Girder Problem ....(3) 73
Crane Signals, Uniform ....(41) 201
Creosoted Fir in Marine Construction .... (12) 60
Creosoting, Cost of ....(156) 696
Creosoting New Process ....(37) 219
Criticism of Architects ....(6) 76
Criticism, Construction of Architect (68) 320
Culvert Openings and Drainage Areas .... (72) 324
Curing Conditions, Effect of Concrete .... (57) 309
Current Engineering Literature and Engineers .... (73) 349
Curvature Arches, Direct Design of (15) 85
Curvature, Effect on Railway Maintenance .... (87) 397
Curves, Life of Special Track Work on .... (140) 658
Cut Off Saw for Piles.............(49) 283
Cutting Timber, Effect of Time on Durability .... (131) 671
Cuyuna Range Stripping by Hydraulic Sluicing .... (141) 659

D

Daily Press Public Service Commissions .... (23) 183
Dam Construction, Hydraulic Fill, Special Features ....(69) 275
Dam, Hydraulic Fill, Calaveras..(15) 39
Dam Slide, Calaveras ....(15) 39
Day Labor in Highway Work......(89) 341
Daylight, and Artificial Lighting, of Buildings ....(151) 691
Daylighting by Inclined Walls....(20) 90
Deactivator System for Preventing Pipe Corrosion .... (31) 221
Deciduous Orchards, Duty of Water for .... (64) 270
Decking, Method of Renewing on Viaduct .... (142) 660
Decorating Walls with Cement...(17) 449
Defining Engineering ....(2) 2
Definition of Engineering..........(24) 184
Definition of Engineering ....(23) 47
Definition of Engineer ....(28) 162
Definitions of Engineering ....(3) 51
Demobilization of Engineer Regiments .... (51) 303
Denver Tramway Co., Bonus System .... (126) 526
Design of Booms, Simple Method..(27) 209
Design of Concrete Mixtures......(89) 421
Design, Concrete Wall, Conditions for Economy .... (44) 226
Design, Curvature Arches ....(15) 85
Design of Wooden Dam on Sand..(55) 261
Details, Standardization of School Buildings .... (95) 427
Detroit Water Force and Labor Saving Machinery .... (42) 176
Dew Pond, Construction of ......(19) 451
Differentiation, Graphical ....(137) 677
Dilution by Sewage Disposal.......(24) 456

Disinfection of Water in Small Quantities (53) 287
Dissolved Oxygen, Index of Pollution (9) 33
Ditch Construction with Scarifier (31) 191
Ditcher, Electrically Operated....(13) 61
Ditches, Road, Preventing Erosion (56) 248
Ditches, Road, Erosion ....(46) 156
Ditching, Right of Way, Electrically Operated Ditcher ....(13) 61
Divining Road of Underground Water (33) 465
Dock Gates, Rein. Concrete .....(30) 462
Dome, Reinforced Concrete, Copenhagen (13) 445
Donora, One Course Sidewalks....(5) 5
Drafting Room, Efficiency in......(148) 666
Drafting Room, Up-to-Date ......(127) 587
Draftsmen's Union, Activities and Aims (128) 588
Draftsmen's Union, Chicago ......(48) 158
Draftsmen's Union, Salary Schedule (137) 655
Draftsmen's Salary Schedule and Classification (137) 655
Drag Line Scraper, Quarry Stripping (43) 203
Dragline on Scow for Channel Excavation (149) 667
Draglines, Excavating Miami River (99) 533
Drainage Areas and Culvert Openings (72) 324
Drawings, Filing, Vertical System (120) 554
Dredging, Gold, Power Plants for (14) 52
Dredging, in Isolated Districts....(14) 62
Drill Bit, Blow of...............(108) 542
Drill Bit, Cutting Action of......(102) 542
Drill Steel, Ideal Shop for Sharpening (126) 644
Drilled Wells, Increasing Flow by Shooting (24) 48
Drilling Methods at the Sacramento Hill Copper Mines (79) 389
Dry Dock, Boston, Concreting Plant (75) 385
Dual Water Systems, Limited Applicability (103) 503
Dump Wagons, Trap Loading With (86) 396
Dust Eliminator for Cleaning Empty Cement Bags ....(91) 391
Dust Preventive, Calcium Chloride as (129) 589
Duty of Water for Deciduous Orchards (64) 270
Dynamite, Breaking Up Brick......(7) 55
Dynamite for Breaking Up Concrete (112) 568
Dynamite for Breaking Up Frozen Ore (41) 201
Dynamite Breaking Up Ice Gorges (35) 217
Dynamite for Loosening Hard Soil (136) 654
Dynamite for Removing Trees.... (149) 667
Dynamite in Tree Planting...... (80) 390

E

Earth Embankment ....(48) 282
Earth Embankments, Shrinkage of (48) 282
Earth Moving, Road Construction (91) 343
Earth Pressure Calculations, Simplification (6) 438
Earth Road Construction ....(94) 346
East Boston Tunnel, Grouting.....(80) 390
East Canyon Creek Dam........(139) 623
Economic Duties of Engineers....(33) 193
Economic Ignoramuses in Congress (102) 558
Economic Limit to Motor Truck Weights (6) 6
Economics for Engineering Students (147) 687
Economics of Contractors and Engineers (103) 559
Education of Architect ....(122) 578
Education Campaign for $60,000,000 Road Bond Issue in Illinois (40) 150
Education Continuous, Industrial Slogan (97) 531
Efficiency Engineering, Application to Shoveling (143) 661
Efficiency and Other Factors for Success (36) 196
Electric Railways, Fordizing ....(46) 280
Electric Railway Snow Fighting Equipment (20) 68
Electrically Driven Pumps in Small Waterworks (36) 170
Electrically Welded Joints ....(36) 468
Electrification of Steam Railroads (113) 547
Electrification of Steam Railroads, Possibilities (107) 541
Electricity, Blasting With ....(19) 67
Embankment, Earth Shrinkage ..(48) 282
Embankment, Ripraping with Wire Bag (46) 180
Employees' Suggestions ....(91) 401
Employees' Training ....(88) 398
Engine Room Pointers ....(122) 522
Engine Terminal, Toledo and Ohio Central (131) 649
Engineer, Construction Company...(2) 72
Engineer, Economic Duties of....(33) 193
Engineer, Definition of ....(28) 162
Engineer, Duties of ....(145) 685
Engineer and General Literature..(105) 561
Engineer and Housing Developments (45) 227
Engineer, Individual Aid in Improving Conditions for Profession (70) 322
Engineer and Labor ....(42) 224
Engineer Regiments, Demobilization of (51) 303
Engineer, Restriction of Title....(25) 185
Engineer, Structural and Architect (20) 90
Engineer and War ....(3) 435
Engineering, Definition of ....(2) 2
Engineering, Definitions ....(3) 51
Engineering, Definition ....(2) 72
Engineering, Definition ....(2) 72
Engineering, Definition of ....(24) 184
Engineering, Definition of ....(23) 47
Engineering Graduates, Occupations of (117) 573
Engineering, Highway Transport (130) 590
Engineering Literature and Engineers (73) 349
Engineering Pamphlet ....(37) 219
Engineering Pamphlet, What Shall Be Done With? ....(51) 303
Engineering, Post Graduate Schools of (102) 502
Engineering Profession, Proper Recognition (77) 387
Engineering Professions, Consolidation of (40) 222
Engineering Regiments, Mustering Out (50) 232
Engineering Society and Legislation (70) 322
Engineering Society Purposes.....(82) 414
Engineering Societies Committees, Organization (19) 89
Engineering Societies and Constructive Legislation (51) 303
Engineering Societies, Paramount Duty of (25) 185
Engineering Societies and Public Works (49) 255
Engineering Societies as Post Graduate Schools (95) 529
Engineering Societies and Public Work (1) 1
Engineering Students and Economics (147) 687
Engineering, Structural, College Courses (99) 431
Engineers and Advertisements....(96) 530
Engineers, Co-operation Between Architects (28) 210
Engineers and Current Engineering Literature (73) 349
Engineers, Definition ....(22) 22
Engineers and Demobilization ....(6) 438
Engineers, Economics of Contracting (103) 559
Engineers, Employment by Smaller Municipalities (101) 501
Engineers and Highway Work....(15) 15
Engineers, Intermediaries Between Labor and Capital ....(89) 399
Engineers, Memorize Useful Facts (102) 558
Engineers, Municipal, Education and Training (15) 447
Engineers and Overtime ....(47) 281
Engineers, Pecuniary Rewards of (4) 436
Engineers and Politics ....(155) 695
Engineers, Public Life ....(27) 137
Engineers and Public ....(2) 72
Engineers, Publicity for, Through Local Newspapers ....(25) 207
Engineers Obtain Publicity for Profession (4) 71
Engineers, Railway, Technical....(26) 186
Engineers, Relation Between Civil and Military (10) 58
Engineers, Relation to Contractors (63) 297
Engineers, Recommended Compensation for (25) 208
Engineers, Reconstruction ....(20) 29
Engineers, Salaries, Chicago ......(17) 17
Engineers, Special Notes of........(29) 211
English Channel Tunnel ....(9) 441
English Socialistic Experiment ....(75) 351
Ensign Balanced Valve ....(20) 44
Entrance Pillars, Cost of ....(18) 88
Erosion, Effect of Soil and Grade on Ditches (46) 156
Erosion, Road Ditches, Preventing (66) 248
Essington Works, Heating System (21) 91
Excavating Channel with Dragline on Scow (149) 667
Excavation, Shoveling, Efficiency, Engineering Application ......(143) 661
Excavation, Time Studies in Hand Shoveling (27) 187
Excavation for Miami River Draglines (99) 533
Excavation, Rock, New Classification (134) 652
Experiments with Miles' Acid Process (110) 510
Explosives, Liquid Oxygen ....(34) 466

F

Farm Values and Good Roads......(30) 140
Farming, Increased Cost of........(131) 615
Federal Aid Road Projects, Status (53) 241
Federal Highway Commission, Houston's Opposition to..........(126) 586
Federal Highway Commission, Views of Secretary Houston .... (143) 603
Feeding Method for Garbage Disposal, Baltimore (52) 258
Fees, Engineers, Mahoning Valley (6) 67
Fees, Engineers, Mahoning Valley (6) 76
Fertilizer, Sludge as ....(14) 445
Filing Drawings, Vertical System for (120) 554
Filing System, Southern Sierras Power Co. (125) 525
Filter Fly, Sewage Control.........(61) 267
Filter Plant, Chain of Rocks........(8) 32
Filters, Sand Cleaning, Brookline (110) 510
Financing Highway Improvements, Methods (148) 608
Fineness Modulus, Methods of Grading Concrete Aggregates ....(133) 673
Fir, Creosoted, Marine Construction (12) 60
Fir Lumber, New Process for Creosoting (37) 21
Fire Department, Who Should Pay Operating Expenses? ....(103) 503
Fire Charges, Utility Commission Decisions (117) 517
Fire Hydrants, Protecting Against Freezing (44) 178
Fire Protection Charges ....(117) 517
Fishes and Mosquito Control......(68) 274
Flat Slab Floor Tests, Western Newspaper Union ....(84) 416
Flat Spots on Car Wheels Damaged Rail (112) 546
Floor Tests, Flat Slab at Western Newspaper Union ....(84) 416
Flow, Duration, Service Pipes....(10) 34
Flow, Rates, Service Pipes........(10) 34
Flushing Machine, Street Cleaning (32) 142
Fly, Sewage Filter, Control......(61) 267
Force Account Work by New York State Highway Dept........(151) 611
Force Account in Highway Work (89) 341
Ford Car, Cost of Operating......(76) 386
Fordizing Electric Railways ....(46) 280
Forest Plant Roads ....(33) 465
Form Work, Boston Warehouse (98) 420
Foundations, Gravel ....(42) 152
Founder Engineering Societies as Post Graduate Schools of Engineering (102) 502
Founder Societies for Post Graduate Schools of Engineering......(102) 502
Francois Grouting Process ....(29) 461
Freezing, Protection of Fire Hydrants, Winnipeg (44) 178
Freight Car, First Concrete ....(82) 392
Freight Rates, Comparison with Truck Rates (122) 498
Freight Rates, Increased 15 Per Cent (96) 530
Freight Rates on Road Building Materials (69) 379
Freight Rates on Road Materials (25) 135
Frogs Reclaimed by Welding Process (135) 653
Fuel Conservation and Education of Boiler Room Men ....(98) 374
Fuel, Saving in Power Plant.......(97) 373
Fuse, Safety Selected ....(29) 189
Fuse, Spitting Wet Shaft ....(84) 394
Future Highways ....(83) 335
Future Public Water Supplies, Iowa (114) 514

G

Garbage Collection, Checks On, Philadelphia (27) 161
Garbage Collection, Cost, Columbus, Ohio (156) 640
Garbage Disposal by Feeding to Hogs, Baltimore (52) 258
Gardening, Home Garden Peace Measure (18) 42
Gardens, Back Yard ....(47) 181
Gardens, War .... (3) 27
Gauge Table for Storage Reservoir (121) 577
Gasoline Consumption and Tractive Resistance ....(106) 482
Gates, Lang, Recent Installations (62) 268
General Contractor, Accounting (118) 552
General Literature Engineers Should Read (105) 561
Girder Crane Problem ....(3) 73
Glue Waterproof ....(130) 670
Glued Work, How to Obtain the Best Results (110) 566
Good Roads on Farm Values......(30) 140
Gold Dredging, Power Plants for (14) 62
Government, New Form of.........(51) 257
Government Maps, Railway Surveys (125) 643
Government Monuments and Their Recovery (153) 693
Government Operation of Railways (28) 188
Government Ownership, British Point of View (1) 433
Government Ownership, Telephone (1) 25
Government Ownership of Telephones (1) 49
Government Railway Operations (18) 66
Government Railways, City ....(1) 433
Grade Crossing Elimination, State Roads (141) 659

Grade Crossings, Reducing Traffic (23) 23
Grade Crossing Elimination State Laws (17) 17
Grade Crossings, Provisions for Safety (124) 500
Grade Separation, General Problems (71) 381
Grade Wash, Pot Holes Preventing (82) 334
Grading Aggregates, Fineness Modulus Method (133) 673
Grading Aggregates, Surface Area of (133) 673
Grading, Road (60) 242
Graphical Differentiation and Integration (137) 677
Gravel Base, Cost (42) 152
Gravel, Lake Shore, Road Surfacing (95) 347
Gravel Producers, Cost Accounting (13) 61
Gravel Road Construction, Motor Truck Haulage (116) 492
Gravel, Sluicing and Washing Outfit for (24) 24
Gravel Washing Plant, Miami Conservancy District (106) 540
Grouting Processes, Francois (29) 461
Guarantees Pavement (68) 250

H

Hackensack Water Company, Meter Practices (67) 273
Hand Shoveling, Time Studies (27) 187
Halazone for Disinfecting Small Quantities of Water (53) 287
Hardening Processes of Concrete (14) 446
Hardness of Water, Estimating (38) 409
Hauling, Cost with Motor Trucks (93) 345
Hay Tar Mat for Sand Roads (66) 248
Health and Street Cleaning (16) 16
Heat Treatment, Rail Joints (76) 386
Heathcote System of Concrete (28) 460
Heating, Central Station (59) 265
Heating and Coal (4) 28
Heating System, Essington Works (21) 91
Hetch Hetchy Railroad Motor Truck (87) 397
High Prices, Cause of (131) 671
High Prices, Duration of (74) 406
High Prices, and Public Opinion (129) 613
High Prices, How Long Will They Last? (74) 406
High Prices, Will They Persist? (133) 617
High Wages, Lower Prices (67) 377
Highway Bridges, Loads, British Joint Committee Report (21) 453
Highway Bridges, Maintenance and Painting (54) 306
Highway Bridges and Motor Truck Traffic (111) 487
Highway Bridges, Painting (54) 306
Highway Contract, Competency of Contractor (56) 238
Highway Construction in New Jersey (138) 598
Highway Contractors, Cost Keeping for (52) 234
Highway Costs, 1918 (13) 13
Highway Financing, by License Fee (34) 144
Highway Improvements, Methods of Financing (148) 608
Highway Maintenance in Wisconsin (63) 245
Highway Transport Engineering (130) 590
Highway Work, Convict Labor On (93) 345
Highway Work, Day Labor in (89) 341
Highway Work, Engineers (15) 15
Highway Work, Methods of Contracting For (54) 236
Highways of the Future (83) 335
Highways, Marking, New Hampshire (5) 5
Highways, Marking, Wisconsin (28) 138
Highways, National Motor Trucks (3) 3
Highways, Relation to Railways (71) 253
Highways, Relation to Street Systems (67) 249
Highways, Sandhill Region, Nebraska (149) 609
Highways, Snow Removal (69) 251
Highways, Snow Removal (57) 239
Hoisting Cables, Oiling in Place (149) 667
Hollow Building Tile, Strength (79) 411
Home Garden, Cost and Returns (143) 627
Home Gardening as Peace Measure (18) 42
Horse Maintenance, Cost (146) 630
Horses, Cost of Feeding, Cincinnati (151) 611
Hot Mix, Bituminous Pavements (139) 599
Hot Water Supply Pipes, Deactivator System for (39) 221
House Connections, Effect on Water Consumption (144) 628
Houses, Small, Today's and Pre-War Costs (152) 692
Houses, Wood, Concrete for (13) 445
Housing, Cradock, Va. (4) 52
Housing Development and the Engineer (45) 227
Houston's Secretary, Opposition to Federal Highway Commission (126) 586
Hydraulic Fill Dam Construction, Special Factors (69) 275
Hydraulic Fill Dam, Failure (15) 39
Hydraulic Sluicing for Stripping (141) 659
Hydro Electric Development, General Factors Affecting the Cost (65) 271
Hydro Electric Plant at Bombay (30) 462

I

Ice Gorges, Breaking Up with Dynamite (35) 217
Ice Gorges at Bridges with Pile Driver Hammer (110) 556
Ice Making, Water Dept (26) 160
Industrial Lighting, General Principles of (144) 684
Illinois and Road Building (68) 378
Illinois Specification for Concrete Roads (101) 477
Illogical Tests of Intelligence (75) 351
Incentive Wage Plan, Standards for (147) 665
Industrial Slogan for America—Continuous Education (97) 531
Industrial Railway for Road Building (64) 246
Insects in Swimming Pool (30) 164
Inspection of Bridges, Special Points Require Special Observation (141) 681
Inspection, Periodic, of Bridges (30) 212
Inspection of County Roads (65) 247
Insurance, State Compensation, California (144) 628
Intelligence, Illogical Tests of (75) 351
Intelligence, Vocabulary Test of (85) 361
Interstate Commerce Commission, Railway valuation (39) 199
Interstate Commerce for Drinking Water Supplies (107) 507
Interstate Commerce Commission, Why Engineers Should Be Appointed (123) 641
Iowa Road Work, 1918 (59) 241
Iron Ore Frozen, Breaking Up with Dynamite (41) 201
Iron Removal from Water Supply of Wausau (43) 177
Irrigation Canal, Removal of Algae (146) 630
Irrigation Projects, Quantities of Water Used (5) 29
Irrigation Tunnel, Porto Rico, Cost (92) 368
Irrigation Water, Device for Metering (71) 277
Irrigation Water, Measuring (35) 169

J

Jackhamer for Cutting Old Timber (122) 556
Jitneys, Number in Operation (2) 51
Joints, Concrete Pavement, Straight Edge for (53) 235
Joints, Electrically Welded (36) 468

K

Kitchen Garden, Waterworks Men (26) 160

L

Labor, Efficient Utilization of Labor in Railway Maintenance (92) 402
Labor and Engineer (42) 224
Labor, Payment of by Results (6) 438
Labor Prices, Road Work (112) 488
Labor Saving Devices for Railway Maintenance (54) 288
Labor Saving Equipment, Track Maintenance, B. & O. (5) 53
Labor Saving Machinery, Detroit Water Dept. (42) 176
Labor Saving, Pay Roll Accounting (89) 399
Labor Saving, Pay Roll Writing (91) 401
Labor Unions and Increased Productivity (24) 206
Laboratory, Testing, Municipal, Organization (132) 592
Laborers, Handling Mexican Track (134) 652
Lake Shore Gravel for Road Surfacing (95) 347
Lamps for Outdoor Lighting (21) 70
Land Clearing, Stump Removal in (101) 535
Lang Gates, Recent Installations (62) 268
Language, a Tool for Reasoning (1) 71
Law Uniform, Motor Trucks (10) 10
Laws, State, Grade Crossing Elimination (17) 17
Laying Pipe, Estimated Cost (13) 37
Leakage New Water Mains (53) 259
Leamington, Circular Concrete Reservoirs (147) 631
Legal Obstacles to Public Work (1) 1
Legislation and Engineering Society (70) 322
Legislator, Typical and the Manufacturer (126) 586
License Fees, Motor Vehicles (44) 144
License Law for Engineers (88) 340
Licensing Building Contractors (128) 584
Light Railways and Motor Trucks (74) 384
Lighting, Daylight and Artificial (151) 691
Lighting, Industrial, General Principles (144) 684
Lighting Outdoor, Size of Lamps (21) 70
Lime Softening of Water (88) 364
Liquid Oxygen Explosives (34) 466
Living Architecture (88) 420
Loading Stations, Multiple for Handling Road Materials (143) 603
Local Improvements, Special Assessments (16) 16
Logging Spur, Method of Staking Out (31) 191
Lubrication of Air Compressors (57) 291
Lumber, Correct Moisture Content of (125) 581
Lumber, Creosoting, New Process (37) 219
Lumber, Rules for Piling (156) 696
Lynn Water Supply, Pumping Units for (121) 521

M

Macadam, Bituminous (147) 607
Macadam Old, as Pavement Base (98) 474
Macadam Surface Treatment, Wisconsin (55) 237
Thomas H. MacDonald, Chief Bureau of Public Roads (85) 337
Machine Finishing Concrete Roads (115) 491
Machine Flushing, Street Cleaning (32) 142
Machinery, Labor Saving, Road Work (39) 149
Management Books, List of (149) 673
Management, Common Defect (2) 50
Manager and Employees, New Relations (90) 400
Manganese Removal from Water Supply, Wausau (43) 177
Mahoning Valley, Engineers' Fees (6) 76
Maintenance Pavement, Financing (69) 251
Maintenance, State Reward Roads, Michigan (121) 497
Maintenance of Way Work, Equating Track Section for (65) 299
Marine Construction, Creosoted Fir, for (12) 60
Massachusetts, Highway Traffic (7) 7
Mechanical Hauling, Michigan (22) 22
Meter Installation, Cost (41) 175
Meter Practices of the Hackensack Water Company (67) 273
Meter Repairs, Cost, Los Angeles (54) 260
Meter Testing, Cost, Detroit (41) 175
Meterage in Oak Park, Ill. (137) 621
Metering, Financial Benefits of (31) 165
Metering, Reducing Water Consumption (38) 172
Metering, San Francisco (80) 356
Meters, Repairing Cost, Detroit (44) 178
Meters, Service Selection (4) 175
Meters, Testing, Hackensack (67) 273
Mesh Reinforcement, Device for (47) 157
Mexican Track Laborers (134) 652
Miami Conservancy District, Gravel Plant (106) 540
Miami River Improvements, Draglines (99) 533
Miles Acid Process Sewage Treatment (110) 510
Military Engineers, Relations (10) 58
Milk Drivers Paid More Than Assistant Professors (124) 642
Mine, Coating Roofs with Cement Gun (16) 64
Mining Tunnel, Cost of (52) 286
Mining Tunnel, Cost of (117) 551
Minnesota Engineers and Reconstruction (20) 20
Moisture Content of Lumber (125) 501
Moisture Resistance of Spar Varnish (136) 676
Monuments, Government, and their Recovery (153) 693
Mosquito Control by Fishes (68) 274
Motor Flushing Procedure, Rochester (32) 142
Motor Truck, Bituminous Surfaces (61) 243
Motor Truck Carriers, Rates (8) 8
Motor Truck Drivers, Bonus System (79) 331
Motor Truck, Efficient as Its Body (104) 538
Motor Truck on Hetch Hetchy Railroad (87) 397
Motor Truck and Highway Bridges (111) 487
Motor Truck Haulage, Gravel Road Construction (116) 492
Motor Truck Operated on Railroad Track (36) 196
Motor Truck Weights, Economic Limit (6) 6
Motor Vehicles, License Fees for (34) 144
Motor Vehicles, Massachusetts (7) 7
Motor Trucks, Adaption for Hauling Cars on Light Railways (75) 384
Motor Trucks and Car Shortage (14) 14
Motor Trucks, Cost of Hauling (93) 345
Motor Trucks, Dimensions, Regulation (10) 10
Motor Trucks, Highways (3) 3
Motor Trucks, Patrol Service (9) 9
Motor Trucks, Short Bank Line Railways (24) 184

Motor Trucks, Short Line Railroads ....(57) 291
Motor Trucks, Uniform Law......(10) 10
Mountain Roads, Concrete Pavements for ....(85) 337
Mucker, Aristocrat of the Labor World ....(50) 302
Multiple Loading Stations for Handling Road Materials ....(143) 603
Municipal Bond Issues, Limit for..(25) 159
Municipal Cement Plant, Los Angeles ....(73) 325
Municipal Engineer, Training of..(38) 470
Municipal Engineers, Education....(15) 447
Municipal Engineers, Salary Schedule ....(131) 591
Municipal Ownership Experiments with Traction Lines ....(124) 642
Municipal Railway, San Francisco, Operating Cost ....(24) 184
Municipal Railway System of San Francisco ....(97) 531
Municipal Revenue and Liquor Traffic ....(26) 136
Municipal Surveyors, New Spirit..(31) 463
Municipal Testing Laboratory, Organization ....(132) 592

N

New Boulevard Link, Sidewalk Construction, Chicago ....(119) 495
New Castle System for Recording Real Estate Titles ....(102) 478
New Designs of Pavements, Experimenting ....(127) 587
New England, Rainfall Records...(54) 260
New England, Road Work Cost...(13) 13
New Jersey Highway Construction.(138) 598
New Relations Between Manager and Employes ....(90) 400
New York Canals, Tonnage 1918...(24) 48
New York City and Water Companies ....(50) 256
New York State Highway Dept., Force Account ....(151) 611
New York Water Supply, Sanitary Regulations Protection ......(136) 620
Nitro-Glycerin for Shooting Water Wells ....(38) 172
Non-Metallic Mineral Products, Value ....(76) 408

O

Occupations of Engineering Graduates ....(117) 573
Office Bonus System ....(90) 400
Office Records, St. Louis, Water Division ....(21) 45
Oiling Hoisting Cables in Place...(149) 667
Oil Storage Reservoir, Computing Gauge Table for ....(121) 577
Oil Storage Tanks, Concrete......(52) 304
One Course Sidewalks, Finishing Paving for ....(101) 477
One Man Light Weight Car for Street Car Operation ....(96) 530
One Man Trolley Cars, Operation of.. ....(35) 195
Operating Cost, Truck and Trailer.(130) 590
Orange Peel Bucket in Catch Basin Cleaning ....(30) 164
Organizations of Contractors......(85) 395
Outdoor Lighting Lamps for......(21) 70
Outlet, Reservoir Freezing........(12) 444
Outlet Work, Large Capacity, U. S. Reclamation Service ....(19) 43
Outlets, Large Reservoirs ....(19) 43
Overhead Charges Between City Department ....(40) 174
Overtime and Engineers ....(47) 281
Oxy-Acetylene Welding Process for Reclaiming Frogs ....(135) 653
Oxygen, Dissolved, Index of Pollution ....(9) 33

P

Pack Mules for Carrying Rock....(98) 532
Painting, Cost, Steel Truss and I-Beam Bridges ....(71) 323
Pamphlet, Abstract ....(24) 206
Pamphlet, Engineering ....(37) 219
Pantheon of Brooklyn Bridge.....(130) 670
Paravane for Sweeping Up Mines...(8) 440
Pathfinder Dam, Sliding Gates.....(20) 44
Patent Cases, Technical Courts for.(23) 205
Patrol System, Wisconsin..........(38) 148
Patrol System, Wisconsin..........(63) 245
Pavement, Life of..................(49) 231
Pavement Base, Old Macadam for.(98) 474
Pavement Brick, General Features.... ....(103) 479
Pavement, Brick, Present Status..(86) 338
Pavement, Core Drilling Outfit for.(89) 341
Pavement, Cost, Little Falls, N. Y... ....(151) 611
Pavement, Guarantees ....(68) 250
Pavement Maintenance, Financing.(69) 251
Pavement Markings with White Bricks ....(136) 596
Pavement, Recommendations for Width ....(96) 348
Pavement on Trunk Highways, Minimum Width ....(96) 348
Pavement, Wood Block, Bituminous, Paint Coat ....(44) 154
Pavement, Wood Block Service Test, Minneapolis ....(36) 146
Pavement, Wood Block, Specification.. ....(41) 151
Pavements, Brick, Special Type...(113) 489
Pavements, Concrete, for Mountain Roads ....(85) 337
Pavements, Core Drilling Outfit...(89) 341
Pavements, Experimenting with New Designs ....(127) 587
Paving Roller for One Course Sidewalks ....(101) 477
Paving, Wood Block, Concrete Base for ....(41) 141
Paving, Wood Block, Street Car Tracks ....(71) 253
Pay Check Writing, Labor Saving.(91) 401
Pay of Railway Technical Engineers.. ....(26) 186
Pay Roll Accounting, Labor Saving Devices ....(89) 399
Pay Roll Accounting, Saving Labor.... ....(89) 399
Pay Roll, Labor Saving in.........(91) 401
Payment of Labor by Results......(6) 438
Peace Prices and War Wages.....(49) 301
Pedestal Track Construction......(150) 668
Percentage Contractors ....(132) 650
Periodic Inspection of Bridges.....(30) 212
Piece Rate System, Vote Against..(47) 281
Piece Work, Removing Distrust of.... ....(121) 555
Piers, Brick, Column Formulas....(95) 427
Piers, Shed Capacity for..........(26) 208
Piles, Cutting Off Below Water Line.. ....(49) 283
Piling, Creosoted Fir..............(12) 60
Pillars, Entrance Cost ....(18) 88
Pioneer Railway, Pontoon Bridge for ....(18) 450
Pipe Corrosion, Deactivator System.. ....(39) 221
Pipe Laying, Cost..................(13) 37
Pipe Lines, Cost of Pumping Through ....(118) 518
Pitch, Paint Cost Method, Specification ....(41) 151
Planer, Road, Winslow ....(72) 254
Plans for School Buildings, Standardization ....(61) 313
Pneumatic Caissons, Bridge Piers.(106) 562
Pneumatic Tools, Separators for Removing Water ....(41) 201
Pneumonia and Waterworks Engineers ....(130) 614
Politics and Engineers ....(155) 695
Pollution Dissolved, Oxygen as Index.. ....(9) 33
Pollution, Sewerage Disposal ....(9) 33
Pontoon Bridge, Improvement.....(149) 689
Pontoon Bridge for Pioneer Railway.. ....(18) 450
Pontoons, Rein. Concrete, Sydney.(23) 455
Portable Shops for Construction, Equipment Repair ....(70) 380
Portable Shops, U. S. Army........(70) 380
Portier Grouting Process..........(29) 461
Portland Cement, Production and Price ....(108) 564
Post Graduate Schools, Engineering Societies ....(95) 529
Pot Holes, Preventing Grade Wash in ....(32) 334
Power Plants, Bonus System for...(93) 369
Power Plants, General Factors Affecting Cost ....(65) 271
Power Plant, Saving Fuel in.......(97) 373
Power Scrapers for Handling Coal.(121) 521
Preliminary Railway Surveys, Use of Compass ....(42) 202
Presidential Address, F. S. Curtis.(145) 685
Pressure, Effect on Water Consumption ....(144) 628
Prices Will Continue High.........(129) 613
Prices, Yesterday, Today and Tomorrow ....(104) 504
Prices, Underlying Cause of.......(104) 504
Prices, War, Readjustment Period.(108) 564
Primers, Methods of Electric Blasting Caps ....(112) 546
Prison Labor, Snow Removal ......(21) 21
Professionalism, Fetish of ....(74) 406
Professions, Evolution from Trades... ....(129) 669
Professors, Assistants and Pay of Milk Drivers ....(124) 642
Psychological Tests Useless........(50) 302
Psychology and Efficiency..........(36) 196
Psychology in Rating Scale.........(82) 358
Public Charity or Public Works...(27) 137
Public Commission, Railway Wages... ....(46) 280
Public and Engineers ....(27) 72
Public Improvement, Bond Laws...(45) 179
Public Improvements, Bonded Indebtedness, American Cities......(47) 181
Public Ownership, Street Railways..(3) 51
Public Service Commissioner for Daily Press ....(23) 183
Public Utility Commission on Fire Charges ....(117) 517
Public Utility Rates................(3) 27
Public Works and Capital..........(50) 232
Public Works Construction, Forces Account, Worcester ....(12) 12
Public Work Construction and Soldiers ....(13) 13
Public Work Contracts, Unit Price.(92) 344
Public Work and Engineering Societies ....(1) 1
Public Work and Engineering Societies ....(25) 185
Public Work, Legal Obstacles to....(1) 1
Public Works, Buffer Employment.(41) 151
Public Works and Engineering Societies ....(49) 255
Public Works or Public Charity....(27) 137
Public Works and Prices ....(26) 136
Publicity and Engineers ....(4) 74
Publicity for Engineers Through Local Newspapers ....(25) 207
Pumps, Booster, Quincy, Ill........(124) 524
Pumps, Centrifugal, Horsepower Requirements ....(153) 637
Pumps, Electrically Driven ....(36) 170
Pumping, Cost, Detroit.............(48) 182
Pumping, Cost, Through Pipe Lines... ....(118) 518
Pumping Units, Lynn, Water Supply ....(121) 521
Purification Plant, Operating Results, St. Louis ....(17) 41
Purification of Water, Cost, St. Louis ....(17) 41

Q

Quarries, Blasting, Costs ....(8) 56
Quarry Stripping with Drag Line...(43) 203
Quarrying, Cost of ....(44) 154
Quarrying, Safety Rules for.......(140) 658

R

Rabut System of Reinforcing Metal.. ....(23) 455
Rail Canting ....(70) 380
Rail Damaged by Flat Spots on Freight Car Wheels ....(112) 545
Rail Failures, Observations on.....(106) 540
Rail Joints, Heat Treatment.......(76) 386
Railroad Construction, 1918.........(17) 65
Railroad Construction Near Chicago.. ....(56) 290
Railroad Yard Construction, Chicago.. ....(56) 290
Railroad Ties, Zinc Chloride Treatment ....(84) 394
Railroads, Government Operation..(28) 188
Railway Appraisal, Cost of.........(45) 279
Railway Construction, Cost Plus Contracts ....(105) 539
Railway Construction and Engineers.. ....(25) 185
Railway Curve Resistance, Causes.(98) 532
Railway Employes, Wage Increases of ....(131) 671
Railway Improvements, Program, 1918 ....(22) 69
Railway Income, Deficit ....(47) 281
Railway, Industrial Road Building.(64) 247
Railway Maintenance, Effect of Curvature on ....(87) 397
Railway Maintenance, Labor Saving Equipment for ....(5) 53
Railway Maintenance, Labor Saving Devices for ....(54) 288
Railway Maintenance, Utilization of Labor in ....(92) 402
Railway Operations, Government...(18) 66
Railway Surveying, Preliminary Compass ....(42) 202
Railway Surveys, Government Maps.. ....(125) 643
Railway Technical Engineers, Pay of. ....(26) 186
Railway Technical Engineers, Salary Schedule ....(83) 393
Railway Ties, New Method of Preserving ....(103) 537
Railway Tie, Reinforced Concrete..(39) 471
Railway Track Construction, Concrete ....(93) 403
Railway Tunnel, Concreting, in Service ....(60) 294
Railway Valuation, I. C. C., Status.(39) 199
Railway Wages, Public Commission.... ....(46) 280
Railways, Electric, Snow Fighting Equipment ....(20) 68
Railways, Relation to Highways...(71) 253
Railways, Short Branch Line Motor Trucks ....(24) 184
Rainfall Records, Muscatine, Ia...(128) 528
Rainfall Records, New England....(54) 260
Rate Piece, Vote Against..........(47) 281
Rate of Fare, Street Railway Wages Based on ....(125) 643
Rates for Motor Truck Carriers.....(9) 9
Rates, Public Utility................(3) 27
Rating Scale, Selection of Officers..(82) 358
Ration List, Construction Camps..(52) 286
Real Estate Titles, Recording System for ....(102) 478
Reasoning, Language as Tool for....(1) 71
Reconstruction, Minnesota Engineers.. ....(20) 20

Reconstruction Period, Contracting for. ....(54) 236
Recognition of Engineering Profession, How Obtained ....(77) 387
Record Keeping, Visible Index System ....(42) 202
Recording System, Real Estate Titles.. ....(102) 478
Records in Office, St. Louis, Water Division ....(21) 45
Refuse Collection, Columbus, Cost.(156) 640
Reinforced Concrete Construction, Unit System ....(35) 467
Reinforced Concrete Dome, Copenhagen ....(13) 445
Reinforced Concrete Walls for Uncovered Reservoirs ....(134) 618
Reinforcement Mesh, Straightening.(47) 157
Reinforced Metal, New Form....(23) 455
Repaving, Determining, When....(49) 231
Repaving, Determining, When ....(75) 327
Reservoir, Oil Storage, Gauge Table for ....(121) 577
Reservoir Outlet, Freezing ....(12) 444
Reservoir Outlets, Large, U. S. Reclamation Service Experience...(19) 43
Reservoirs, Circular, Concrete, Leamington, Ont....(147) 631
Reservoirs, Uncovered, Reinforced Concrete Walls for ....(134) 618
Retaining Wall for Concrete, Sectional ....(139) 657
Revetment, Bank, Concrete....(43) 203
Right of Way Ditching, Electrically Operated Ditcher ....(13) 61
Riprapping with Wire Bag....(46) 180
River Bank Protection, Skeleton, Steel ....(135) 653
River Mud, Cohesion of....(11) 443
Rivet Furnaces, Air Syphon Blowers ....(40) 222
Road Building, Industrial Railway..(64) 246
Road Building Material, Freight Rates on ....(69) 379
Road Construction, Aransas County, Tex....(135) 595
Road Construction, Convict Labor.(14) 14
Road Construction Under War Conditions ....(4) 4
Road Construction, Earth Moving Methods ....(91) 343
Road Construction, Inspection ....(65) 247
Road Contractors and Bonding Companies ....(123) 499
Road Corrugation, English Experience ....(21) 21
Road, Cost per Mile....(109) 485
Road Design, Regulation of Traffic.(76) 328
Road Ditches, Erosion of....(46) 156
Road Ditches, Method of Preventing Erosion ....(66) 248
Road Dragging, Financing by Local Subscription ....(95) 347
Road Dragging with Tractor Outfit.(94) 346
Road Dragging, Winter....(33) 143
Road Engineers, Salary Schedule..(131) 591
Road Grading with Blade Grader-Tractor Outfit ....(60) 242
Road Grading with Tractor Outfit.(94) 346
Road Grading and Tractors....(16) 16
Road Gravel, Cost of Obtaining....(24) 24
Road Gravel, Motor Truck Haulage in ....(116) 492
Road Machinery ....(145) 605
Road Maintenance, Cost, Colorado..(19) 19
Road Maintenance, Michigan....(121) 497
Road Maintenance, Patrol, Maine....(9) 9
Road Maintenance, Patrol System, Wisconsin ....(38) 148
Road Maintenance, Rural Areas....(9) 441
Road Materials, Handling by Multiple Loading Stations ....(143) 603
Road Materials and Freight Rates.(25) 135
Road Patrol System ....(9) 9
Road Planer, Winslow ....(72) 254
Road Projects, Federal Aid, Status.(59) 241
Road Resurfacing, Cost, with Tarmac ....(39) 471
Road Scarifier, New ....(39) 471
Road Surfaces, Damage to by Heavy Vehicles ....(16) 448
Road Surfacing with Lake Shore Gravel ....(95) 347
Road Surfacing, Marquette County.(39) 149
Road Surfacing with Sand Clay...(135) 595
Road Surveys, Federal Aid, Cost...(54) 236
Road Wear, English Experience....(21) 21
Road Work, Cost, Alabama....(19) 19
Road Work, California, Cost....(87) 379
Road Work, Cost, in New England.(13) 13
Road Work, Cost, Wisconsin....(72) 254
Road Work, Iowa ....(59) 241
Road Work, Labor Saving Machinery.. ....(39) 149
Road Work, New York State, Bidding Prices ....(136) 596
Road Work, Unit Bidding Prices.(112) 488
Roads, Bamboo, Burma....(31) 141
Roads, Concrete, Reinforcing....(17) 449
Roads, Concrete, Illinois, Specification. ....(101) 477
Roads Constructed Through Sandhill Regions ....(149) 609
Roads on Farm Values....(30) 140
Roads, Forest Plank ....(33) 465
Roads, Mountain, Pavement ....(85) 337
Roads, Relocating, Contour Method... ....(117) 493
Roads, Roman, Alignment ....(24) 456
Roads, Sand Covered with Hay Tar Mat ....(66) 248
Roads, Sand, New Mexico....(45) 155
Roads, Tractive, Resistance of....(106) 482
Roads, Winter Dragging....(33) 143
Rock Crushing, Cost of....(44) 154
Rock Excavation, Blasting, Costs...(8) 66
Rock Excavation, New Classification.. ....(134) 652
Rodding to Increase Strength of Concrete ....(109) 543
Rolling Concrete Roads....(30) 140
Rolling, Effect on Rusting of Iron and Steel ....(43) 225
Roman Roads, Alignment of....(24) 456
Roof Construction, Sawtooth ....(12) 82
Roof Trusses, Steel, Formula for..(132) 672
Roof, Wooden, Cost of Removing..(51) 257
Roundhouse Design, Modern Tendencies ....(141) 659
Rules for Piling Lumber....(156) 696
Rural Motor Express, Business Prospects for ....(102) 602
Rural Motor Express, Field for....(150) 610
Rural Planning, Topographical Surveys ....(20) 20
Rusting, Chemical Theory of....(25) 207
Rusting, Iron and Steel, Effect of Rolling on ....(43) 225
Rustless Steel ....(117) 573

S

Sacramento Hill Copper Mines, Stripping ....(79) 389
Safe Sight Distance for Automobiles... ....(108) 484
Safety Fuse, Selection ....(29) 189
Safety Rules for Quarrying....(140) 658
Safety Treads, Stairways ....(17) 87
St. Louis, Water Division, Office Records ....(21) 45
Salaries of Assistant Surveyors in Ireland ....(3) 435
Salaries, English Assistant Surveyors.. ....(16) 448
Salaries for Engineers, Canadian Engineering Society ....(124) 580
Salaries, Water Works Superintendent ....(131) 615
Salary Schedule, Railway Technical Engineers ....(83) 393
Salary Schedule for Road Engineers... ....(131) 591
Salesmanship, Contracting System.... ....(127) 583
Sand Clay for Road Surfacing....(135) 595
Sand Filters, Cleaning, Brookline..(110) 510
Sand Production, Cost Accounting for. ....(119) 553
Sand Hill Regions, Road Construction. ....(140) 609
Sand Roads, Hay Tar Mat for....(66) 248
Sand Roads, New Mexico....(45) 155
Sand, Wood Dam Built on, Design.... ....(55) 261
San Francisco Municipal Railway..(24) 184
Sanitary Regulations for Protection of New York Water Supply....(136) 620
Saw Cutting Off Piles....(49) 283
Sawtooth Roof Construction....(12) 82
Scarifier, Ditch Construction....(31) 191
Scarifier, Road, New ....(39) 471
Schedules for Getting Out Work on Time ....(119) 553
School Building Plans, Standardization ....(61) 313
School Buildings, Inclined Walls...(20) 90
School Buildings, Standardization of Details ....(95) 427
Screen Wheel for Algae Removal..(146) 630
Screw Spikes ....(81) 391
Sejourne System, Wilson Bridge....(4) 74
Separators for Removing Water from Pneumatic Tools ....(41) 201
Secretary Houston's Views on Federal Highway Commission ....(143) 603
Sectional Concrete Wall, Cleveland, Youngstown ....(139) 657
Service Meters, Selection ....(41) 175
Service Pipes, Portland ....(44) 178
Service Pipes, Rates of Flow in...(10) 34
Service Test, Wood Block Pavement.. ....(36) 146
Sewage, Analysis of ....(33) 465
Sewage Disposal by Dilution....(24) 456
Sewage Disposal, English Cantonment ....(24) 456
Sewage Filter Fly, Control of....(61) 267
Sewage Treatment, Miles, Acid Process ....(110) 510
Sewer, Concrete, Ottawa, Cost....(38) 172
Sewer, Tile, Cost, Ottawa....(38) 172
Sewer, Rideau River ....(38) 172
Sewerage, Bacterial County in ....(32) 166
Sewerage, Buenos Aires....(28) 162
Sewerage Disposal by Pollution....(9) 33
Shed Capacity for Piers....(26) 208
Sheds, Umbrella, for Railway Stations ....(105) 561
Sheet Asphalt, Removal, Between Street Car Tracks ....(33) 193
Ships, Concrete, Economic, Size....(31) 463
Shipyards, Construction of ....(21) 91
Shop, Sharpening Drill Steel....(126) 644
Short Line Railroads, Motor Trucks.... ....(57) 291
Shoveling, Application of Efficiency Engineering to ....(143) 661
Sidewalk Construction, New Boulevard Link, Chicago ....(119) 495
Sidewalks, One Course, Donora....(5) 5
Signals, Crane, Uniforms ....(41) 201
$6,000,000 Road Bond Issue in Illinois, Educational Campaign for....(40) 150
Skeleton, Steel, River Bank Protection ....(135) 653
Slag, Requirements for Aggregating in Concrete ....(68) 320
Sludge, Analysis of ....(33) 465
Sludge Treatment, English Cantonment ....(24) 456
Sludge, Use as a Fertilizer....(14) 446
Sludge as Aid in Water Softening... ....(88) 364
Sluicing and Washing Outfit, Road, Gravel ....(24) 24
Smoke Nuisance, Civil Engineers..(50) 256
Snow Fighting Equipment, Electric Railway ....(20) 68
Snow Plow, Street Gutter ....(37) 469
Snow Removal, Highways ....(57) 239
Snow Removal from Highways....(69) 251
Snow Removal with Prison Labor..(21) 21
Snow Removal, Steam Shovel....(24) 24
Snow Removal, Toronto, Highway.(84) 336
Socialistic Experiment in England.(75) 351
Soil and Gravel Conditions, Effect on Ditch, Erosion ....(46) 156
Soil, Hard, Loosening with Dynamite.. ....(136) 654
Soldiers and Public Work....(13) 13
Spar Varnish, Moisture Resistance of. ....(136) 676
Special Assessments and Local Improvements ....(16) 16
Special Engineer's Note Book....(29) 211
Special Track Work, Life on Curves... ....(140) 658
Specification for Pitch Paint Cost Method ....(41) 151
Specifications, Uniform ....(125) 581
Speed Regulation, Motor Trucks....(10) 10
Spitting Fuse In a Wet Shaft....(84) 394
Stairways, Safety Treads....(17) 87
Standards, Drinking Water Supplies... ....(107) 507
Standards for Incentive Wage Plan.. ....(147) 665
State Compensation Insurance, Premium Rates ....(144) 628
State Constitution, Archaic ....(26) 136
State Engineering Society and Engineer ....(97) 473
State Highway Construction, California Status ....(84) 336
State Highway, Contract Prices, Texas ....(64) 246
State Highway Work, Convict Labor, California ....(80) 332
State Highway Systems, Marking..(5) 5
State Laws for Grade Crossing Elimination ....(17) 17
Steam Railroad Electrification, Possibilities of ....(107) 541
Steam Railroads, Electrification of.(113) 547
Steam Roller, War-Time Repairs..(36) 468
Steam Shovel, Snow Removal ....(24) 24
Steam Shovels, Track Arrangements.. ....(38) 198
Steel, Effect of Rolling on Rusting... ....(43) 225
Steel Mill Building, Design....(111) 567
Steel Price and Mr. Hines....(103) 559
Steel Roof Trusses, Table Weights of ....(132) 672
Steel Water Main, Capacity....(143) 627
Sterilizing with Chloramine....(90) 366
Stone & Webster, Experience in Operation of One Man Trolley Cars ....(35) 195
Storage Bin for Coaling, Contractors' Equipment ....(71) 381
Storing Timber to Prevent Decay..(62) 314
Straight Edge, Testing Concrete Pavement Joints ....(53) 235
Street Car Tracks, Removal Sheet Asphalt ....(33) 193
Street Car Tracks, Wood Block Paving ....(71) 253
Street Car Transportation, Economic Improvement in ....(96) 530
Street Car Unions, Conductorettes.(124) 642
Street Cleaning, Cost, Columbus...(120) 496
Street Cleaning and Health....(16) 16
Street Cleaning, Machine Flushing for ....(32) 142
Street Gutters, Snow Plow for....(37) 469
Street Railways, City Ownership, Seattle ....(3) 51
Street Railway Construction, Modern Appliances ....(139) 657
Street Railway Track, Cost....(40) 200
Street Railway Track Standards, Chicago ....(110) 544
Street Railway Tracks Without Ties... ....(113) 547
Street Railway Wages, Rate of Fare.. ....(125) 643
Street Systems, Connection to Highways ....(67) 249
Street Systems, Relation to Highways ....(67) 249
Strikeboard, Cutting Circular Arc..(42) 152

Stripping on Cuyuna Range, Hydraulic Sluicing .... [illegible]
Stripping Methods at the Sacramento Hill Copper Mines ....(79) 389
Structural Engineer and Architect [illegible]
Structural Engineering Courses, Objects [illegible]
Structural Engineering Courses...(119) 575
Structures, Theory of, New Principles [illegible]
Stucco, Cost of Applying Centrifugal Stucco Gun [illegible]
Stump Removal, Methods ....(101) 535
Subgrade Preparation, Cost of [illegible]
Success, Efficiency as Factors.....(36) 196
Sunlight to Town Planning........(107) 483
Surface Area, Method of Grading Aggregates [illegible]
Surface, Area Method for Proportioning Aggregates [illegible]
Surface Treatment, Macadam, Wisconsin [illegible]
Survey, Water Waste, Buffalo......(61) 267
Surveys, Contour of Relocating Roads ....(117) 493
Surveys, Federal Aid, Cost.........(54) 236
Surveys, Railway, Government Maps [illegible]
Surveys, Staking Out Logging Spur.. [illegible]
Surveys, Topographical, Rural Planning [illegible]
Surveys, Water Waste [illegible]
Sweeping Up Moored Mines, Invention for [illegible]
Swimming Pools, Insect Development [illegible] 164
Switch Points, Reclaiming ....(135) 653

T

Tamping Bags, Blasting [illegible]
Tanks, Oil Storage, Design of......(52) 304
Tar Painting Machine ....(22) 454
Tarmac for Road Resurfacing [illegible]
Technical Cases, Technical Courts for [illegible]
Technical Courts for Technical Cases.. [illegible]
Technical Engineers, Pecuniary Rewards [illegible]
Technical Journals, Censoring ......(4) 435
Technical Men, Co-operation Between Architects ....(28) 210
Telegraph System, Government Ownership [illegible]
Telephone and Telegraph, Government Ownership [illegible]
Temperature Records of Concrete..(7) 55
Temperature Variations in Concrete... [illegible]
Terminal, Engine, Columbus, Ohio.(131) 649
Testing Laboratory, Organization of.. [illegible]
Testing, Method, Concrete, New York [illegible]
Testing Stations for Water Purification Plant Design ....(115) 515
Thawing Water Services, Cost.....(156) 640
Theory of Structures, A New Principle [illegible]
Tie Railway, Reinforced Concrete..(39) 471
Tie Renewals [illegible]
Tie and Timber Conservation in Canada [illegible]
Ties, Railroad, Zinc Chloride Treatment [illegible]
Ties, Railway, New Method of Preserving [illegible]
Ties, Substitute for Timber........(81) 391
Ties, Treated, Experience Santa Fe [illegible]
Ties, Zinc Treated ....(29) 189
Tile, Hollow, Building Strength...(79) 411
Timber Conservation, Canada.....(100) 534
Timber Cutting [illegible]
Timber, Cutting Effect of Time on.(131) 671
Timber, Storing to Prevent Decay..(52) 314
Time Cards for Laborers, Boston Army Supply Base Contract [illegible]
Time Keeping System, Boston Army Supply Base [illegible]
Time Studies in Road [illegible]
Toledo and Ohio Central Engine Terminal ....(131) 649
Topographical Surveys, Rural Planning [illegible]
Town Planning, Relation of Sunlight to [illegible]
Tracings Recorded ....(50) 284
Track [illegible]
Track Ballast, Methods of Cleaning.... [illegible]
Track Construction [illegible]
Track Construction in [illegible] Costs [illegible]
Track Construction [illegible]
Track Elevation, Aspects of........(71) 381
Track Laborers, Mexican [illegible]
Track Maintenance, Labor Saving Equipment [illegible]
Track Section [illegible] Work [illegible]
[illegible] Railways System ....(110) 544
Track, Street Railway, Cost........(40) 200
Tracks, Street Cars, Removal of Asphalt ....(33) 193
Traction Lines, Municipal Ownership [illegible]
Tractive Resistance in Terms of Gasoline Consumption [illegible]
Tractor, Operating Costs, Colorado.(19) 19
Tractor [illegible]
Tractor, Fuel Consumption [illegible]
Tractor [illegible]
Trades, Evolution Into Professions.... [illegible]
Traffic Census, Massachusetts .....(7) 7
Traffic [illegible]
Traffic [illegible]
Transmission Through Building Materials [illegible]
Transmission of Heat Through Building Materials [illegible]
Trap Loading with Dump Wagons.(86) 396
Treated Ties, Experience of Santa Fe [illegible]
Tree Planting, Dynamite as Aid...(80) 390
Tree Removal with Dynamite.....(149) 667
Trenching, Cost of with Machine [illegible]
Trolley Cars [illegible] Operation of [illegible]
Truck Operation, Items to Be Considered ....(137) 597
Truck Rates, Comparison to Freight Rates [illegible]
Truck and Trailer, Operating Cost.... ....(130) 590
Trucks, Operating Costs [illegible]
Trucks and Trailers in City Hauling.. [illegible]
Trunk Highways, Wisconsin System of [illegible]
Tunnel [illegible]
Tunnel, Grouting with Low Alumina Cement [illegible]
Tunnel [illegible] Cost [illegible]
Tunnel, Mining, Copper Mountain, Cost [illegible]
Tunnel [illegible]
Tunnels, Pressure Flow in.........(34) 466
Tunnel, Railway, Concreting in Service [illegible]

U

Umbrella vs. Butterfly Sheds for Railway Stations [illegible]
[illegible]
[illegible]
[illegible]
[illegible] Increased Productivity [illegible]
Unions, Street Car Conductorettes..... [illegible]
[illegible] Contract [illegible]
[illegible]
Unit System, Reinforced Concrete Construction ....(35) 467
[illegible]
[illegible]
[illegible]

V

[illegible]
Valuation Railway, I. C. C. Status (39) 199
Vertical Lift Bridge, Pa. R. R. ...(81) 413
[illegible]
Virginia, Minn., Waterworks Operations ....(87) 363
[illegible]
[illegible]

W

Wage Increases of Railway Employes.. [illegible]
Wage Plan, Incentive Standards for... ....(147) 665
[illegible]
Wages, High and Lower Prices....(67) 377
Wages, Railway, Public Commission... ....(46) 280
[illegible]
Wall, Reinforced Concrete Design..(44) 226
Walls, Reinforced Concrete, Economies [illegible]
War Conditions, Road Construction.(4) 4
War Cost, Errors in Estimating....(2) 26
War [illegible]
War [illegible]
War Wages and Peace Prices......(49) 301
Warehouse, Form Work for........(98) 430
Warehouse, Steel, Wind Bracing...(22) 454
Water [illegible]
Water Bills, Method of Handling..(76) 352
Water [illegible]
Water [illegible]
Water Conduit, Economical Section for [illegible]
Water Consumers' Account, Block System of Handling ....(153) 636
Water Consumers' Accounts, Handling ....(76) 352
Water Consumption in Army Cantonments ....(26) 160
Water Consumption, Effect of Pressure on ....(144) 628
Water Consumption, Hartford......(70) 276
Water Construction in Average Dwellings [illegible]
Water, Deciduous Orchards ....(64) 270
Water Departments in Ice Making.(26) 160
Water, Disinfecting in Small Quantities [illegible]
Water Effect on Concrete...........(57) 309
Waterworks Engineers and Pneumonia ....(130) 614
Water Extracting, Dissolved Gases from [illegible]
Water Filtration, St. Louis..........(8) 32
Water, Flow in Pipes..............(44) 466
Water, Hardness, Estimating......(38) 470
Water Heater for Winter Concreting.. ....(15) 63
Water Irrigation, Metering ....(71) 277
Water on Irrigation Projects........(5) 29
Water, Irrigation Recording Deliveries [illegible]
Water Main, Carrying Capacity..(143) 627
Water Main Cleaning, St. Louis....(7) 31
Water Main, Cost of................(46) 180
Water Main Extension, Meeting Cost of [illegible]
Water Mains, Cost, Council Bluffs.(139) 623
Water Mains, Cost, Los Angeles....(53) 259
Water Mains, Leakage, New.......(53) 259
Water Power of World.............(40) 472
Water Purification Cost, St. Louis.(17) 41
Water Purification, St. Louis......(17) 41
Water Purification Plant Design, Testing Stations for ....(115) 515
Water, Quantity Required for Mixing Concrete ....(94) 426
Water Services, Effect on Consumption [illegible]
Water Service, Small Cities.........(91) 367
Water Services, Thawing Costs.....(5) 29
Water Softening for Contractors' Locomotives [illegible]
Water Softening, Features of Plant.... [illegible]
Water Softening Plant, Cleveland..(78) 354
Water Softening Plant on Construction [illegible]
Water Softening, Grand Rapids....(88) 364
Water, Softening with Lime.......(88) 364
Water Supply, Milwaukee, Coal Tar Waste [illegible]
Water Supply, Milwaukee, Obnoxious Odor of ....(145) 629
Water Supply, Wausau, Wis........(43) 177
Water Supply [illegible]
Water Supplies, Bacteriological Standards ....(107) 507
Water Supplies, Future, Iowa.....(114) 514
Water Systems, Dual, Limited Application of [illegible]
Water Testing Station, Cost of....(116) 516
Water Treatment, Cost of Chemicals [illegible]
Water Underground, Divining Road... [illegible]
[illegible]
Water Waste, Methods of Controlling, Oak Park ....(137) 621
[illegible]
[illegible]
Wells, Increasing Flow by Shooting... [illegible]
Wells, Shooting with Nitro-Glycerin.. ....(38) 172
Water Waste Survey, Buffalo......(61) 267
[illegible]
[illegible]
Waterways, Relation to Highways.(71) 253
[illegible]
Waterworks, Electrically Driven Pumps [illegible]
[illegible] of ....(74) 350
Waterworks Men, Kitchen Garden..(26) 160
[illegible]
Waterworks Operations, Virginia, Minn. [illegible]
Waterworks Superintendent, Salary of ....(131) 615
Welding, Oxy-Acetylene, for Reclaiming [illegible]
[illegible]

[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]

W[illegible] Concreting, Heating Water (1) [illegible]
W[illegible] Government Ownership (1) [illegible]
W[illegible] Experience in Road Maintenance [illegible]
W[illegible] Road Maintenance (38) 148
W[illegible] System of Marking Trunk Highways [illegible]
Wood Block Pavement, Experience with Bituminous Paint Coat Method (44) [illegible]
Wood Block Pavement Service Test, Minneapolis (36) 146
Wood Block Pavement, Specifications. (41) [illegible]
Wood Block Paving, Smooth Top Concrete Base for (31) 141
Wood Block Paving, Street Car Tracks (71) 253
Wood Concrete for Houses . . . .(13) 145
Wood Paving Blocks, Increasing Strength by Impregnation....(11) 443
Wooden Root, Cost of Removing (51) 257
Wooden Dam on Sand, Design (55) 261
Worcester, Force Account, Public Work ....(12) 12

Z

Zinc Chloride Treatment, Railroad Ties .(84) 394

AUTHORS INDEX

A

Abrams, Duff A. (133) 673; Abrams, Duff A. [illegible] Abrams, Duff A. [illegible] Acheson, Maj. Wm. M. (86) 338; Allen, Kenneth (9) 33; Allen, Leslie H. (127) 583; Austin, O. P. (104) 504.

B

Babbitt, H. E. (134) 618; Banks, Robert T. [illegible] Barbour, Frank A. [illegible] Barnes, E. A. (88) 398; Barnes, O. A. (90) 366; Barnett, Robert C. (6) 6; Barrows, H. K. [illegible] Black-well, C. H. (47) 229; Blanchard, Arthur H. (145) 605; Bosshard, R. E. (39) 173; [illegible] Knickerbocker (28) 210; Boyle, James E. (150) 610; Bradlee, Henry G. (35) 195; Bradt, S. E. (40) 150; Breed, H. E. (44) 144; Brown, Paul E. (109) 609; Brown, W. S. (12) 82; Button, Ellis R. (41) 141.

C

Carr, E. G. (115) 491; Carson, H. Y. (43) 225; Christie, Gilbert (12) 444; Chubbock, [illegible] E. D. (121) 577; Coleman, G. P. (93) 345; Collins, J. A. (142) 602; Conrad, H. V. (57) 291; Culver, Richard J. O. (38) 220; Curtis, Fayette S. (145) 685.

D

Daggett, Gordon F. (117) 493; Darling, W. L. (132) 650; Dean, A. W. (147) 607; Dierdorff, I. E. (45) 179; Dobbin, Clarence E. (61) 313; Donaghey, J. T. (63) 245; Dorr, Edgar S. (110) 510; Duren, George A. [illegible]

E

Easdale, W. C. (24) 456; Eaton, E. Court (146) 630; Edwards, Capt. Llewellyn N. (38) 198; Edwards, W. R. (41) 175; Eddy, Harrison P. (70) 322; Enger, M. L. (86) 362; Ewing, D. D. (36) 170.

F

Fenkell, George H. (31) 165; Ferriss, H. R. (18) 88; Finley, W. H. (42) 224; Fitzpatrick, F. W. (68) 320; Fixmer, H. J. (76) 328; Fleming, R. (3) 73; Fleming, R. (105) 561; Fleming, R. (29) 211; Fleming, R. (37) 219; Fleming, R. (63) 315; Flinn, A. D. (40) 222; French, D. W. (67) 273

G

[illegible] (19) 43; Gillette, Halbert P. (4) 28; Gillette, Halbert P. (52) 234; Gillette, Halbert P. (47) 281; Gillette, Halbert P. (75) 351; Gillette, Halbert P. (99) 431; Gillette, Halbert P. (8) 440; Gillette, Halbert P. (133) 617; Gilman, George H. (126) 644; Godfrey, Edward (119) 575; Goldman, H. A. [illegible] 580; Gordon, John H. (54) 236; Gould, Carl F. (122) 578; Graf, August V. [illegible] 41; Graham, Alexander W. (92) 341; Graham, George M. (10); Grondal, Bror L. (12) 60; Grunsky, C. E. (69) 275.

H

Habermeyer, G. C. (118) 518; Hale, Frank E. (56) 262; Hambleton, F. T. (14) 446; Harley G. Townsend (143) 661; Hastings, L. M. (54) 260; Heermans, T. M. (153) 637; Henny, D. C. (15) 39; Higgins, Lafayette (114) 514; Hill, Emery S. (141) 659; Hinkle, A. H. (57) 239; Hirst, Arthur R. (28) 138; Hirst, Arthur R. (38) 148; Holden, T. S. (108) 564; Hubbard, Prevost (61) 243; Husson, Joseph, (137) 597; Hutchinson, Cary T. (108) 508.

I

[illegible] W. R. [illegible] 193

J

Jones, Bassett (151) 691; Jones, Sullivan W. (86) 418; Judson, Everett (107) 507.

K

Keith, Herbert C. (30) 212; Keith, Herbert C. (141) 681; Kirchoffer, W. G. (43) 177; Knight, Thomas M. (38) 172; Kueling, H. J. (66) 248.

L

Lea, Allan B. (28) 162; Lewis, Nelson P. (16) 16; Lockmund, Oscar (52) 286; Lohman, F. C. (69) 251; Longwell, J. S. (35) 169.

M

MacLean, J. D. (36) 146; Martin, L. U. (66) 248; Mason, R. P. (64) 246; Matte, Herbert P. (137) 621; Matte, H. P. (144) 628; May, Donald C. (62) 268; McClenahan, W. T. (115) 515; McGrath, Tom P. (118) 553; McVicar, A. R. (91) 343; Mengel, F. F. (60) 242; Montfort, W. F. (90) 366; Moritz, E. A. (5) 29; Mullen, John H. (15) 15; Murray, Marshall L. (132) 672.

N

[illegible], Lewis P. (67) [illegible] Newsom, Reeves J. (121) 521; Nisbet, W. C. (92) 402; [illegible], W. H. [illegible] 20

O

O'Rourke, John F. (63) 297

P

Paaswell, George (44) 226; Parker, Benjamin L. (10) 80; Parker, A. E. (139) 623; Pasco, B. G. (31) 191; Pennybacker, L. E. (148) 608; Pinkerton, C. W. (114) 548; Pneuman, J. M. (20) 68; Preston, J. O. (132) 592; Pride, George H. (71) 253; Proctor, Edward M. (147) 631.

R

Rankin, R. S. (115) 515; Raymond, Arthur (27) 209; Raymond, Arthur (78) 410; Rhodes, Albert T. (12) 12; Routh, James W. (32) 142; Russell, S. R. (35) 217; Rutherford, George A. (83) 415.

S

Sargent, Paul D. (9) 9; Sargeant, Paul D. (50) 284; Saunders, W. L. (59) 293; Saville, Caleb Mills (10) 34; Sohier, Wm. C. (13) 13; Seymour, H. L. (107) 483; Shirley, H. G. (8) 335; Skov, L. W. (65) 317; Sloman, M. S. (16) 64; Smith, F. P. (139) 599; Snead, Charles D. (54) 306; Sparrow, W. W. K. (77) 387; Speller, F. N. (39) 221; Sperry, W. A. (88) 364; Stein, Milton F. (32) 166; Stimson, E. (5) 53; Stinchcomb, W. A. (155) 695; Stuart, Francis Lee (28) 188; Swain, George F. (139) 679; Swigart, Charles H. (15) 39.

T

Talbot, Arthur N. (19) 89; Teesdale, C. H. (36) 146; Thompson, W. G. (138) 598; Towne, L. J. (7) 55.

U

Upham, Charles M. (89) 341

V

Van Dyke, C. W. (52) 304

W

Watson, M. W. (17) 17; Weatherway, L. A. (118) 552; Webb, James A. (9) 441; Wehrle, George (13) 37; Wenderoth, Oscar, [illegible] 76; Wenderoth, Oscar (96) 428; Weymouth, C. R. (65) 247; White, John C. (59) 265; Wilkinson, F. (38) 470; Williams, A. D. (14) 14; Williams, Clement C. (23) 17; Williams, E. O. (31) 463; Witmer, Dr. Lightner (36) 196.

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Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power

Railways and Govt. Works—3rd Wednesday
(a) Excavation and Dredging
(b) Rivers and Canals
(c) Harbors and Docks
(d) Railway Construction

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Ship Construction
(d) Miscellaneous Structures

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E. & C. Index Furnished Only on Request

Hitherto it has been customary to send the index of our articles to every subscriber. In order to conserve paper the index for the six months ending Dec. 31 will be sent only to subscribers who send a postal card or letter requesting a copy of the index. We will then list your name so that you will receive the index twice each year without the necessity of writing us. It will assist us if those desiring the index will notify us at once.

Legal Obstacles to Economic Public Work Expansion and How Engineering Societies Can Aid in Removing Them

Mr. J. R. Benton, secretary of the Florida Engineering Society, has asked the editor to point out some of the present legal obstacles to the economic expansion of public works. In his letter he states that it is quite possible that the society might like to make some recommendations along this line to the State Legislature or to city councils.

Some of the legal obstacles to the economic expansion of public works are:

The low debt limit placed on cities by state laws or charters is a bar to progress. Railway companies usually issue bonds to the extent of 75 per cent of the cost of their plants. If a city builds sewers, water works, pavements, etc., judiciously, it provides "plants" that should be bondable. A bond limit of 2 per cent on the assessed value of all property in a city is much too low a limit. Moreover it has no relation to the profitableness of public improvements.

The assessment of the entire cost of street improvement against abutting property is as serious an economic blunder as was the similar assessment of country road costs against adjacent farms. Highways, whether in cities or in the country, should be largely, if not entirely, paid for from general funds. We now have Federal and state aid laws to encourage road building, and they are working well. Why not have city aid laws to encourage street improvement? Not half the mileage of streets in cities and less than half in villages can be called fit for motor vehicle traffic. Let the city at large pay for two-thirds the cost of street improvement, the abutting property paying for the balance, and let 20-year bonds be issued. Then adequate progress in street improvement may be looked for.

The county commission system of county management is a serious obstacle to progress. The county commissioners should act merely like a board of directors of a company, and they should be capable business men and successful farmers. They should select an engineer as county manager, and he should be the executive head of the county. He should preferably be an engineer endorsed by the state society of engineers.

Where large cities exist the county government should be merged in the city government.

The operation and maintenance of city plants designed by engineers should be under the managerial direction of engineer. Thus the operation of water, sewer and street maintenance and cleaning departments should be either under the direction of the city Engineer or under special department engineers. Managerial engineering not only increases the efficiency of such departments, but leads to prompt improvement and extension of the plant. The term "plant" is here used in its broad sense. A street system, for example, is part of the transportation plant that serves every citizen. Street maintenance is as much an engineering job as pavement design and construction. The cleaning of streets is a part of street maintenance, and should be so treated.

State laws and city charters frequently prohibit cities from selling water to people outside the city. This is an economic mistake, and prevents the development and extension of thousands of municipal water plants. Water should be used extensively for irrigating gardens, even in most of the so-called humid parts of America. If city water works could be enlarged and extended so as to render this irrigation service not only to city residents but to suburban residents, every one would be greatly the gainer. Water for irrigation of such gardens can be sold at a very low rate and still yield a splendid profit on the investment.

Relatively few municipal water works are now managed by engineers, which largely accounts for the fact that city garden irrigation has never been encouraged. In addition, legal obstacles have often prevented cities from extending their water systems into the surrounding country.

State law and city charters usually fail to provide for the joint ownership and operation of water works by two or more cities. If such restrictions were removed, there would be many economic consolidations of city water works.

Laws relating to water rights are very bad in many states, so bad that irrigation and hydroelectric developments are discouraged. A study of such laws and conferences with local irrigation and power companies will disclose what is needed in each state.

Local engineering societies in each state can perform a public service of vast importance if they will study local laws with a view to recommending changes to legislatures and city councils. It will be more effective if committees of engineers present such recommendations in person and support them by word of mouth. The endorsement of other professional and business organizations should be secured, if possible. In seeking such endorsement an effort should be made to impress the fact that all engineers are primarily economists, that very few engineers have any political axes to grind, and that engineering societies advocate changes in laws and ordinances only for the purpose of securing more economic administration of public affairs.

Is It Worth While Attempting to Define Engineering?

One of our contemporaries has recently said that although nearly everyone knows who is and who is not an engineer, it seems impracticable to define an engineer in a way that will be wholly satisfactory to all. Our contemporary seems to imply that it is a fruitless task to try to frame a definition of engineering, but with such an opinion we can not agree.

When any one says that he knows perfectly well what a given term means but can not define it, it may be questioned whether he has as clear an idea of the significance of the term as he thinks he has. Certainly no engineer who is accustomed to write specifications would admit that he could not specify what is concrete, or cast-iron pipe, or macadam, or clearing and grubbing, or any of the terms used in his specifications. Yet to define is to specify, and to specify is to distinguish by stated characteristics or "marks."

It is our contention that engineering can be defined, and that it should be defined. We admit that differences of opinion may always exist as to who should be called an engineer, for as we said in our Dec. 4 editorial discussion of the subject: "It should be recognized at once that no definition of any class of mental activity can be framed that will perfectly define the boundary line between it and other classes, unless some more or less arbitrary division is established." Obviously where men must agree upon an arbitrary line of division there is not only chance for dispute, but certainty that any dividing line selected today will not necessarily remain in force 10 years hence or even a year hence. Nevertheless, it is not a fruitless task to define terms even if there is certainty that the definitions are to be changed later. The main object of definition is to secure a definite mental picture of the thing defined, so that when two or more men use the same term they will have the same mental picture, also so that when any man uses the same term at different times he will have the same mental picture unless he has chosen to change the meaning of the term.

Logicians are unanimous in urging the importance of defining all terms, and works on logic contain numerous illustrations of fallacies arising from the use of ambiguous terms. Engineers have usually not studied logic, and, as a result, their specifications are often so carelessly worded as to open the way for litigation. This point, however, is merely incidental to our present theme.

Although the main object of defining terms is to secure freedom from ambiguity, that is not always the sole object. Thus in the case of the word "engineer" one object of definition is to convey to the public a proper conception of the scope of the work of the modern engineer. There is no doubt that the public still holds to the conception of an engineer as being a man who merely designs machines and structures. That, in fact, was the conception of engineering that prevailed in most engineering colleges 15 years or so ago. The conception of the engineer as one who applies any science in an economic manner has even yet not spread to all engineers.

If it desired to prove that the public still has a narrow and almost antique idea of engineer, turn to the definitions of engineering in any dictionary. The following are two typical definitions:

Engineering, in its modern and extended sense, is the art and science by which the mechanical properties of matter are made useful to man in structures and machines. —Webster's Dictionary.

Engineering; the art of constructing and using engines and machines; the art of executing civil or military works which require a special knowledge or use of machinery, or the principles of mechanics.—Century Dictionary.

In Encyclopedia Americana (1912) Prof. George F. Swain endorses Thomas Tredgold's old definition as still being the best, namely: "Engineering is the art of directing the great sources of power in nature for the use and convenience of man."

For thirteen years Engineering and Contracting has contended that such definitions of engineering are behind the times, to say nothing of other objections to them. They all fail to include management engineering or the application of science to the management of men; and they fail to state the prime function of the modern engineer which is to apply science (any science) to the problems of economic production.

In our issue of Dec. 11, Mr. Isham Randolph objects to the definition of engineer that we gave in our issue of Dec. 4, which was: "An engineer is one whose vocation is the systematic study and application of science to the problems of economic production." His objection seems to lie mainly in the fact that under this definition it matters not whether the engineer works in the interest of humanity or to accomplish the destruction of his fellow men. He says: "What we require is a definition suited to the pursuits of peace, and we want the kind of engineer who can 'benefit mankind' by his knowledge, skill and experience. We want a human engineer, not a cold, abstract being whose effort is centered on a creation which has no relation to human welfare."

We reply by asking whether we want any class of men on earth to be other than human and humane? If all classes were to conform to this ideal—and surely no one wishes it otherwise—then it would be fruitless to define engineers as being men who work "for the benefit of mankind," for such a definition would apply equally well to every class of men and therefore would be no definition at all. We engineers can scarcely hope to maintain ourselves upon a pedestal above every other class of men, although it is a worthy ambition to seek to have other classes regard us as deserving the highest praise.

Mr. A. H. Krom has written this definition: "An engineer is one who economically directs man power, and, by scientific design, utilizes the forces and materials of nature for the benefit of mankind." Mr. Randolph favors the inclusion of the last five words, which we regard as superfluous unless it shall be generally thought desirable to emphasize the altruistic nature of an engineer's labor. We certainly have never regarded altruism as anything but an admirable trait. We doubt, however, the right of any class of men to use altruism as a distinguishing mark. Are engineers more altruistic than doctors, than architects, than any one of dozens of other classes that might be named? If not, then is it not both unscientific and somewhat egotistic to lay claim to a characteristic that is found in many other classes of men? We were not dogmatic about this point in our editorial of Dec. 4 and we are not dogmatic now. We repeat that "it may be desirable thus to emphasize the public service that civil engineers perform."

There is a further objection to the use of the words "for the benefit of mankind" in a definition of the word engineer, aside from superfluity. If those words are introduced the question is at once raised whether many military engineers are not excluded from the class engineer. Mr. Randolph apparently implies that at least some military engineers should be excluded, for he says: "The men who produce these things [engines of war] are engineers and their productions may benefit one group of mankind while it destroys another group and causes unutterable misery. The devilish manifestations of this class of engineering skill have been too evident upon the battlefields of Europe." If any military engineers are to be excluded from a definition of engineer because their work is not "for the benefit of mankind," must not all be excluded? Doubtless the German would exclude the British engineer who invented the "tank" and the American engineer who invented the "caterpillar wheels" that made the tank possible; for, by German standards, those engineers did not work "for the benefit of mankind" when they aided in defeating Germany. Must we, then, ascertain the judgment of all mankind as to whether a given man has worked "for the benefit of mankind" before we can decide whether or not he may be classed as an engineer? It seems clear that if we introduce any question of morality into a definition of engineer, we at once raise endless difficulties. Yet we can not avoid questions of morality if we use such an expression as "for the benefit of mankind." This is well illustrated by Mr. Randolph's own use of the expression "devilish manifestations of this class of engineering."

It should be recalled that Thomas Tredgold probably had in mind "civil engineers," as distinguished from "military engineers," when he wrote his definition of engineering. Perhaps Mr. Krom and Mr. Randolph also had in mind a similar distinction. We, on the other hand, were attempting to define all engineers, military as well as civil.

C. C. Williams of Kansas University has prepared the following definition: "Engineering is the science, art, and business of utilizing the forces and materials of nature and the abilities of men to promote the welfare and prosperity of mankind." This definition retains the old Tredgold conception of altruism, and is in other respects similar to Mr. Krom's definition. It has the defect of not being sufficiently specific, for it applies quite as well to an intelligent, up-to-date farmer as it does to an engineer. An engineer systematically studies science with a view to applying it economically or with the maximum conservation of labor, materials and time; and he makes this study and application of science his vocation. A farmer does not make the study and application of science his vocation; that is only an incidental part of his work.

Disputes over definitions often degenerate into fruitless quibbles, but where the definition is that of a class of men, and where the public has either a misconception or an inadequate conception of the functions of that class, it can not be said that it is fruitless to try to specify the class. If engineers were more commonly regarded as practical economists than merely as mathematicians and designers, there would be vastly more work of great economic importance placed under their direction than there now is.

Since the foregoing was written we have come upon a discussion of "What Is an Engineer," by A. W. Allen, in the Engineering and Mining Journal, which we reprint in full in another column.

Half a Billion Dollars for Federal Roads Asked by the Highway Congress

The Highway Congress, a joint session of the National Association of State Highway Officials and the Highway Industries Association, on Dec. 12, adopted a resolution recommending an independent Federal Highway Bureau and an interstate road system to be constructed and maintained by the Government. They also favored a Federal appropriation of half a billion dollars for roads, to be spent at the rate of $100,000,000 annually.

In our issue of Dec. 4 we urged the separation of the present Office of Public Roads from the Department of Agriculture, and the creation of an independent Department of Highways. We also urged an immediate Federal appropriation of several billion dollars for roads. Although the Highway Congress did not go so far as to ask for several billions, it did ask for half a billion, which is five times as much as any association has hitherto recommended. However, we still feel that the Highway Congress was altogether too low in its estimate of the sum of money that can be and should be economically invested in improved roads by the Federal Government. Even in normal times a Federal expenditure of $100,000,000, or less than $1 per capita, would be inadequate. In these abnormal times of "reconstruction" there is economic justification for the expenditure of 20 times that sum during 1919.

In this connection we may add that no civil engineer who takes a really broad view of economics will advise a city, county or state to curtail expenditures until prices and wages fall. Such action will be the surest way to make them fall, it is true, but the fall is apt to be a crash. There is the greatest economic need right now of more work—work on a large scale. Private companies and individuals have their hands more than full in trying to give employment to discharged soldiers and war workers. It is a duty—a real economic necessity—to provide employment for these men, and no city, county or state should shirk this duty in the slightest.

National Highways and Motor Trucks

To the Editor: National highways for motor vehicles will be one of the most discussed engineering problems for [illegible]

After a careful study of the conservation of national resources, the canal as constructed and used in Europe, has opened the eyes of America to the possibilities in that great field of transportation. Following the canal the highway system as constructed in Europe, furnishes food for thought among American engineers and the question arises, can we not profit by their experience and at the same time improve on their construction and methods?

[illegible] American engineers for the last 25 years. I am sorry to say that the most important point is not, "How can we build the best and lasting roadway?" but we see the signs, "Roadway experiment No. 1 to No. 10," etc., where the [illegible]tion, "How far can we stretch the money and how little can we give for the money and get away with it?" Are the present results from a lack of foresight among good roads boosters, or a lack of education and knowledge of the matter?

[illegible] grandfathers loaded a ton of produce on the farm wagon and with two teams spent several days going to market through mud and mire more or less deep; then came the plank and toll road with its sure foundation of a certain degree of stability, and at last came the motor car and truck. With each improvement in the construction of roads came the ever increasing load, until now, the 10-ton truck with its 10 to 15-mile speed is not an unusual sight, and it is with this condition the highway officials and engineers must contend.

Will a modern national highway system of good roads develop a heavier truck? Will we in a few years have a 15 to 20-ton truck, and must we in our plans of today look forward and design our construction to meet such conditions?

Will the concrete, brick and macadam roads we are now building stand up against the heavy truck traffic of the coming years? This seems to me to be a question of vital importance. Supposing we construct concrete or brick roadways at $25,000 per mile and in 5 years find that the truck traffic is pounding them to pieces, would it not be a wise proposition to stop now and consider and possibly pay a little more per mile for something that is everlasting?

Your first French lesson in road construction will be the straight lines between towns and cities. When you figure the initial expense of construction per mile, the maintenance, the wear and tear on roads and vehicles, the cost of gasoline or motive power, the more direct lines for roads are by far the most economical. In America we frequently go 160 miles around when the direct route is but 100 miles. This is not the French way.

The next lesson in road construction is that a good road will cost real money and a cheap roadway is better left unbuilt. The part of the road you cannot see is the most expensive; that is, the foundation. If we were to build steamships on the same plan that we construct many of our roads, how far from shore would they sail? The foundation of a road is just as important thereto as the solid keel and frame to a ship.

The Government will have from 150,000 to 200,000 trucks and trailers of 3½ to 7-ton capacity on its hands when our troops return from overseas. The question will be, what to do with them. The most feasible plan would be (if we had a good system of roads), to establish post or express routes covering the entire country; the farm products that could be carried from farm to town would pay for the maintenance and give a large return on the investment.

Under the old system of roadways the farmer who is 5 or 6 miles from the railroads will not ship his produce, neither will he raise special truck for city consumption; but with the concrete or brick roadway, a distance of 25 miles can be covered in the time 5 miles are now traveled.

With a general national highway system through the various states the question of routes is of great importance. A highway that leads to, but not through a village or city is desirable; as you approach a village the intersecting streets become more frequent, which requires a reduction of speed, and passing through a town the danger of collision increases, which with the loss of speed on account thereof is a waste of time and money. Therefore I would suggest that all interstate or national highways be so constructed as to pass near towns and cities but not through them.

Trans-continental highways should be laid out under a national body, be constructed, managed and maintained by it on a right of way similar to that of a railroad with curves and uniform grades and on direct routes. The roadbed should have proper drainage, cuts fills, and a foundation heavy enough to carry the traffic under the most adverse conditions and should reach every State in the Union.

The writer would like to see the Lincoln Highway constructed as a boulevard, 200 ft. wide, running across the continent with separate traffic and pleasure lines, of sufficient width and strength to carry the heaviest loads. It should be beautified with rows of trees on each side, and should traverse the shortetst route between points, and again would suggest that it pass through no cities or villages en route. EDGAR A. ROSSITER.

Chicago, Ill.

Rapid Road Construction Under War Conditions

Two interesting cases of speedy road construction under war time conditions were described by Mr. Clinton Cowen, State Highway Commissioner of Ohio, in a paper presented Dec. 9 at the Chicago meeting of the American Association of State Highway Officials. One of these was the improvement of a section of the highway from Columbus, O., to Camp Sherman. Large supplies of good gravel existed at different places almost the entire length of the road to be improved, which was a link of 33 miles connecting improvements formerly made by the State Highway Department. The link as it existed was an old worn out macadam and gravel type of construction without drainage and with many places broken through to the clay. The Deputy of Maintenance prepared and submitted an approximate estimate of cost of a quick and economical but substantial improvement of this road with gravel. The estimate was about $3,300 a mile. This included all road drainage, widening of the shoulders and the surface of 16 ft. of from 4 to 5 ins. of waterbound gravel.

The work was undertaken and carried out, divided into a convenient number of sections, by force account under the immediate supervision of the deputy of maintenance. The total cost of the construction and of maintenance up to the present time is about $3,400 a mile. The exact cost of original construction cannot be separated from the cost of maintenance because the maintenance commenced, of course, on portions of the road before the remainder had been completed. The whole work of constructing the 33 miles was finished in a period of about six months, and this was done without blocking the road against traffic and with very little inconvenience to the public. This was accomplished through the use of good bank gravel and motor truck and horse-drawn wagons.

Immediately on the completion of this road the travel was so great that a double line of motor cars with a capacity of 20-odd passengers was installed, making two round trips a day. The work of maintenance is, of course, continuous, although not expensive.

The other instance cited by Mr. Cowen was the improvement of a 14-mile section of the National Highway. The contract was let in April, 1918, under a cost plus basis. The Government, realizing the importance of this work, lent such assistance through railroad service as congested and restricted conditions of traffic would permit. Prison labor, free labor, auto trucks and horse-drawn wagons were used on each section. With much of the force inexperienced and with organizations more or less imperfect as must obtain on work of this magnitude and under such conditions, the entire stretch of road was completed and opened for travel on Oct. 22, 1918, a period of a little more than six months.

The type of road was brick with mastic filler, 16 ft. wide, upon a 6-in. rolled sandstone base with 6-in. cement curbs. The grading was rather heavy. The estimated cost of the 14 miles was $488,500, which was prepared in January, 1918. The actual cost of construction is not yet fully determined but will exceed the estimate in the neighborhood of 20 per cent, which may be largely accounted for in the increased freight rates and the amount of material used in the construction of a cost plus job over that in a similar job under a straight contract.

To the use of convict labor on this work may be credited a large measure of the success. Although such labor did not exceed possibly 33⅓ per cent, the stabilizing effect it had on free labor was no doubt the means of preventing more or less unsettled conditions.

Road Grading with Board Scraper and Hoist.—Grading on some Michigan roads last season was done with a board scraper pulled by a small gasoline reversible hoist placed on a truck in the center of the road grade. A scraper was hitched to each end of the cable, the center of which was wound on the drum so that as one scraper was drawn out of the ditch with a full load the other was released and backed to the ditch. This method is stated to have been quite satisfactory.

One Course Sidewalks Feature of Donora Concrete Housing Development

One-course concrete sidewalks finished with a roller and wood float came as a natural sequence to the construction of millions of yards of concrete roads throughout the United States. So simple is the method of construction and so successful the results that it is surprising more extensive use has not been made of its opportunities for saving labor and improving construction.

Two-course construction involves the mixing of concrete of two proportions, sometimes results in separation of top course from the base and offers opportunity for the unscrupulous contractor to skimp the base.

The one-course type was decided upon for the subdivision of the American Steel & Wire Co. at Donora, Pa., where an extensive concrete housing development is being completed. Contract was let for approximately 25,000 sq. ft. of 5-ft. walk, 4½ in. thick. The work was handled in much the same way as one-course concrete road construction.

Of especial interest are the steel dividing plates used to separate concrete into 5-ft. slabs, as the plates must not extend above the sidewalk surface if the roller method of finishing is to be followed. Since it is difficult to cut through one-course concrete with a trowel or even to groove the walk deep enough to make sure that the concrete will separate where marked if contraction or setlement occurs, some type of dividing plate is necessary.

Where wooden side forms were used, 3/16-in. steel plates 5 ft. long by 4½ in. in depth were spaced at 5-ft. intervals. Near the top at each end of the plate a small hole was provided so that the plate could be removed with hooks. To prevent concrete from pushing these plates out of position, they were staked near the ends and at the center with steel pins.

On part of the work the forms were of steel. The type of dividing plate used with these patented forms had a projecting part in the shape of a hook on each end which fitted over the vertical web of the channel-shaped side form, the upper flange being cut through to make that possible. Only one stake on level ground, or two on grades, were needed with this type of plate.

Roller and Strikeboard for 1-Course Concrete Walks. Strike Board Levels Concrete ½ in. Above Top of Forms.

Concrete was mixed in proportions of 1:2:3, using crushed blast furnace slag ranging in size from ¼ in. to 1½ in. as coarse aggregate. This gave particles larger than are ordinarily used in sidewalk construction, but little trouble was experienced from this cause when the concrete was finished with a heavy roller.

Care was taken to make adequate provision for expansion. Every 50 ft. a strip of prepared filler ½ in. in thickness was placed across the sidewalk, and where the walk abutted a street curb two thicknesss of filler were used. Between houses and walks a ½-in. joint was placed.

Concrete was deposited directly on the clay subgrade and struck off ½ in. high with a template. Following this, concrete was rolled longitudinally with a 10-in. roller 5 ft. 5 in. long, which weighed 2¼ lb. per lineal inch. Since this roller rested on the side forms after concrete had been compacted to the proper level, it was satisfactory although heavier than is used ordinarily. Immediately after rolling the surface was finished with wood floats, dividing plates were removed, joints grooved and the sidewalk edged.

Finishing One-Course Walk, Showing True Surface Obtained with Wood Floats. Man at Right Is Removing Steel Dividing Strips.

The concreting crew was made up of 14 men, including the superintendent; five men were employed in the mixing crew, three wheeled concrete, two set forms and three did the finishing. Twenty-one hundred square feet was the largest day's work done, while 1,800 sq. ft. was a fair daily average. The mixer was a two-sack batch side dump machine. Usually it was moved four times daily.

On the Donora sidewalk work W. S. Wamser served as superintendent for the contractor, Masters & Mullen Co. of Cleveland, and W. F. Dennis was engineer for the American Steel & Wire Co.

Marking State Highway Systems

The State of New Hampshire has an especially complete system for marking the state highways. Each highway is given a distinctive color or combination of colors. Color bands are painted about two telegraph poles either side of each intersecting highway and on the end posts of all guard rails. If poles are not already erected at intersections they set poles or else paint color bands on metal strips and tack them around trees. It is consequently very hard to get lost on any of the State highways in New Hampshire. In that State a town-line sign is set up at each town line giving the names of two towns. This proves to be of very great convenience to travelers. On some of the State highways concrete or granite mile posts have been set.

Color bands are also used for marking State highways in Connecticut and Massachusetts. North and south routes are designated with blue bands; east and west highways with red bands; and diagonal highways are marked with yellow.

The Economic Limit to Motor Truck Weights

By ROBERT [illegible] BARNETT

[illegible] Missouri.

It has been proposed to limit, by legal enactment, the weight of motor trucks running over our highways. Such a step may temporarily give miles of mediocre highways while postponing further and further the attainment of the real objective—economic transportation.

While thus saving money on pavement we are spending it on operation. In this way we blindly shift the burden from one shoulder to the other. Without a scientific determination of the truck limit, we may readily fall short of true economy. It is hardly probable that a limit set by legislative action will coincide with the true economic limit. Any difference between these two limits becomes an ever present incentive to seek further and further readjustment This adjustment can be had only through the expensive and tedious process of "cutting and trying," unless we promptly develop the science of transportation economics to meet the exigencies of the situation.

As yet the principles of economic highway transportation are in their nascent period. Many criteria are yet to be formulated. Therefore there needs to be undertaken a systematic investigation and an exhaustive study of the factors entering into this branch of transportation before hard and fast rules are laid down for public guidance. To stimulate interest in the carrying out of such a program, it is worth while to take stock, as it were, of our present knowledge, and to point out our deficiencies and the particular lines of data which are yet needed to establish this branch of economics. To this end a program for procedure will first be formulated.

As in the solving of all economic problems, there are four distinct steps to be taken, viz.:

1. To form a complete and definite idea of the objective.
2. To determine and classify the various factors producing or affecting the objective.
3. To determine the quantitative relation between each factor and the desired result, or objective.
4. To determine from the preceding relations an interrelation among the factors such that a maximum economy will obtain.

Following this program for procedure, we first have to establish a clear and adequate concept of the object we are seeking to attain. This may be readily done by considering the use which is made of the truck. The purpose of the motor truck being to convey freight from place to place, over some highway, it is easily seen that the desideratum becomes the conveyance of a given amount of freight per unit of time at the lowest ultimate cost. Hence the objective is to secure those conditions that will permit of attaining the least cost per ton-mile of transportation.

$$\text{The cost per ton-mile} = \frac{\text{Total annual cost.}}{\text{Annual ton-mileage.}}$$

The next and second step in the program for procedure is to ascertain all the factors that affect this unit cost of highway transportation. For convenience, the annual ton-mileage will be kept constant, then the cost per ton-mile will vary directly as the total annual cost. An analysis and classification of this total annual cost of transportation show that the following items must be considered:

1. Interest on cost of physical equipment.
2. Cost of insurance, taxes, licenses, etc.
3. Cost of maintaining equipment.
4. Cost of operation.
5. Cost of administration.
6. Cost of amortization.

These items of cost are affected by three principal factors that contribute to the output of any highway transportation system. These are the roadbed, the vehicles, and the power equipment. Often the power equipment and vehicles are combined in one unit. The larger this unit the less the number of units required to convey a given tonnage in a The total annual cost of transportation is the sum of the specified time, or the less the number of trip required annual cost of each factor, or, stated in concise form,

$$\left(\begin{array}{c}\text{Total}\\\text{annual}\\\text{cost}\end{array}\right) = \left(\begin{array}{c}\text{Annual}\\\text{cost of}\\\text{roadbed}\end{array}\right) + \left(\begin{array}{c}\text{Annual cost}\\\text{of motive}\\\text{power}\end{array}\right) + \left(\begin{array}{c}\text{Annual cost}\\\text{of}\\\text{vehicles}\end{array}\right)$$

The following diagram shows how these three principal factors are subdivided into secondary and tertiary factors:

- 1. Annual cost of roadbed ...
  - 1. Interest on construction cost..
    - 1. Land for right of way.
    - 2. Clearing, grubbing.
    - 3. Grading.
    - 4. Paving.
    - 5. Bridges, culverts and drainage.
    - 6. Fences, signs, markers, safety gates, etc.
    - 7. Engineering and legal expenses.
  - 2. Maintenance ...
    - Repairs
    - Renewals
  - 3. Administration.
  - 4. Amortization.
- 2. Annual cost of power ....
  - 1. Interest on power plant.
  - 2. License and taxes.
  - 3. Insurance.
  - 4. Administration.
  - 5. Garaging.
  - 6. Gasoline.
  - 7. Oil, grease and waste.
  - 8. Drivers' salaries.
  - 9. Maintenance of power plant.
    - Repairs
    - Renewals
  - 10. Amortization of power plant.
- 3. Annual cost of vehicles .. ..
  - 1. Interest on first cost.
  - 2. License and taxes.
  - 3. Insurance.
  - 4. Administration.
  - 5. Garaging.
  - 6. Maintenance
    - Repairs
    - Renewals
  - 7. Amortization.

A careful consideration of these cost items and their composition will disclose to some extent how they are affected by the size and weight of the motor truck. Beginning with the first group of items, it is readily seen that the larger the truck the greater the loading per wheel and therefore the stronger must be the pavement, bridges, and culverts in order to sustain the load. This calls for an increase in the first cost of construction and hence in the interest charge. Likewise the maintenance cost will increase with the wheel load and speed, because the rate of abrasion of the wearing surface increases with the heavier loads as also do the internal stresses leading to the interior displacement of particles, while the shear on planes parallel to the pavement increases as the square of the speed in the case of self-propelled vehicles. An augmented maintenance cost calls for an increase in the administrative work and a larger charge therefor. The cost of amortization will tend to increase with the wheel loads because of the greater value of the pavement to be replaced as was previously seen and also its probable shorter life. From these considerations, we draw the general conclusion that the annual cost of roadbed will increase in some, as yet, unknown way with the increase in size and weight of truck.

Taking the second group of factors—annual cost of power—it is obvious that a larger and heavier truck calls for a larger individual power plant, but, on the other hand, the larger the trucks the fewer trucks required. As a matter of fact, for a given annual tonnage over the same roadway, the work done will remain constant. The measure of this work is the product of the gross tonnage by the unit tractive resistance by the mileage. For any given case this product remains fixed, hence a constant annual amount of energy will be required. As the larger power units will be more efficient, a saving in gasoline will result. Also, with the larger capacity trucks the cost per unit of capacity becomes less, hence there will be a saving in equipment and a smaller interest charge. The item of license and taxes will show some increase, not strictly proportional, with the increase in size of the individual power plant, as will also that of insurance. However, as fewer plants will be required, there would probably be some saving. The total cost of gasoline will diminish, as before stated, with the increase in efficiency of the power plant, as will also that of oil, grease and waste. The driver's salary will remain constant for the individual truck, but owing to the lesser number of the larger trucks, the total cost of the item would decrease. The maintenance charge will increase with the size of the individual power plant as will also the amortization charge. However, it seems likely that the total cost of each of these two items will remain constant or slightly decrease because of the fewer number of power plants required and because the cost of a power plant per unit of power is less for the larger plants. On the whole, it is seen that the increase in the size of the truck tends to decrease the annual cost of power for the entire ton-mileage.

Considering next the third group of factors—annual cost of vehicles—it is apparent that they must be affected by the increase in size of truck or trailer very much in the same way as were the items under group 2. We thus draw the general conclusion that an increase in the size of the truck tends to increase the first factor—annual cost of pavement—while diminishing the second and third factors—annual cost of power and annual cost of vehicles. It is required that an adjustment between these groups of opposing factors be secured such that the minimum cost per ton-mile will result. For this purpose it is necessary to know the quantitative relation between each one of these factors and the wheel load which represents the size, capacity and weight of the truck. To fix better our attention upon these factors affected by the weight of the motor truck, and upon the relations we are seeking, they are listed as follows:

I. Annual cost of roadbed.
  Relation between wheel load and
    1. Cost of paving, bridges and culverts.
    2. Maintenance of paving, bridges and culverts.
    3. Administration.
    4. Amortization.
II. Annual cost of power.
  Relation between wheel load and
    1. Interest on power plant.
    2. License and taxes.
    3. Insurance.
    4. Administration.
    5. Garaging.
    6. Gasoline.
    7. Oil, grease and waste.
    8. Drivers salaries.
    9. Maintenance.
    10. Amortization.
III. Annual cost of power.
  Relation between wheel load and
    1. Interest on equipment.
    2. License and taxes.
    3. Insurance.
    4. Administration.
    5. Garaging.
    6. Maintenance.
    7. Amortization.

From this summary it is seen that we are seeking to determine twenty-one different relations. This brings us to the third step in the program, which is that of determining the functional relation between the wheel load and each of these 21 factors, and thereby the resulting effect upon the total annual cost of transportation for a given ton-mileage. This is the most difficult of all the steps, because in most cases sufficient data have not yet been obtained.

Further experimentation and investigation are necessary before this third step can be completed, hence a detailed discussion of the sought-for relations will be postponed until further data are secured. The object of this preliminary and partial presentation of the subject is to arouse interest in the economic phase of the problem, to stimulate others who are also in position to observe and investigate to do so, and to urge them to present their results from time to time to the engineering profession. In this way more rapid progress will be made towards the scientific determination of the economic size of trucks.

Bidding Prices for Furnishing Motor Trucks and Teams.—The Bureau of Highways of Philadelphia opened bids Dec. 10 for furnishing motor trucks and teams for the use of the Bureau in 1919. The average unit prices stated in these bids per 8-hour day were as follows:

[illegible]

Censuses Show Three Fold Increase in Traffic on Massachusetts Highways in 9 Years

Interesting data on the traffic carried by the highways of Massachusetts were given by Col. Wm. D. Sohier, chairman of the State Highway Commission, in a paper presented Dec. 9 at a meeting of the Association of State Highway Officials. The matter following is abstracted from the paper.

Motor Vehicles and the Highways.—What will our highways have to carry in the near future? We can only judge of this by our past experience. That the motor traffic will increase is sure. This is well shown by the following table, showing the increase, in Massachusetts, in motor vehicles in 6 years, and in the number of operators and the fees collected:

	1912.	1915.	1918.	Per cent increase, 6 years.
Automobiles and trucks	[illegible]	[illegible]	[illegible]	[illegible]
Motor cycles	[illegible]	[illegible]	[illegible]	[illegible]
Operators and chauffeurs	[illegible]	[illegible]	[illegible]	[illegible]
Motor vehicle fees	[illegible]	[illegible]	[illegible]	[illegible]

There are over three times as many automobiles and trucks registered as there were 6 years ago, over three times as many operators, and the fees collected are three times as large. All these fees are spent in maintaining and improving the main highways. In fact, last year, all the main highways were practically maintained with the money collected from this source.

How the truck traffic has increased is shown by the following table:

	1915	1916	1917	1918	Per cent increase, 3 years
Trucks	12,9[illegible]	18,194	2[illegible]	[illegible]	1.71
Automobiles	90,580	118,61[illegible]	11[illegible],801	158,3[illegible]	.7[illegible]
Motor cycles	9,520	10,713	10,956	12,708	.33

At the present time there are a very large number of trucks belonging to the Government, and also trucks owned in other states, which are using the Massachusetts roads, so that the increase in volume of truck traffic is much larger than the above figures indicate.

The number of trucks and commercial vehicles registered has increased from over 12,000 in 1915 to over 32,000 in 1918—more than 2½ times as many trucks as there were three years ago.

Changes in Traffic.—The change that has taken place in traffic is clearly shown by the following table. This is made up from traffic counts taken every 3 years from 1909 to this year. An actual count is made for 14 hours a day for 7 days in August and 7 days in October. The table shows the average number of vehicles that are using the main highways, and is based upon the average count in each of these years at 44 stations on main lines.

AVERAGE DAILY TRAFFIC ON MAIN ROADS OF MASSACHUSETTS

[illegible]

While the traffic has increased very rapidly, actually having increased over three-fold in the last 9 years, it is changing even more rapidly than it is increasing, and the change [illegible] view.

There were only one-third as many light horse-drawn vehicles in 1918 as there were in 1909. There were only one-half as many heavy horse-drawn vehicles. On the other hand the number of automobiles and light trucks using the main highways has increased seven-fold in 9 years.

But what is even more important and makes more difference in the character of road which we must build and maintain, is the increase in motor trucks. In 1909 there were practically no trucks using our roads. In 1912 there was an average of 17. In 1915 there were 45, and in 1918 78, using the counts at the same stations. In other words, the number of trucks using the main highways has increased 4½ times in 6 years.

The change in the traffic is perhaps even more graphically shown by the following table of percentages:

PER CENT OF TOTAL TRAFFIC

	[illegible]	[illegible]	[illegible]	1918
[illegible]	[illegible]	[illegible]	[illegible]	2
Heavy Horse	[illegible]	[illegible]	10	4
Total Horse	[illegible]	34	[illegible]	6
[illegible]	[illegible]	4	[illegible]	7
[illegible]	43	62	78	87

While horse-drawn vehicles constituted 57 per cent of all the traffic on the main highways in 1909, in 1918 there was only 6 per cent of the traffic horse-drawn vehicles, and motor vehicles, which were only 43 per cent of traffic in 1909, were 87 per cent in 1918.

The total traffic using the roads has increased over threefold.

While the horse-drawn vehicles are today only 6 per cent of the total traffic using the highways, the heavy motor trucks—over 1 ton, not on pneumatic tires—have already become 7 per cent of the total traffic.

Perhaps even more significant is the change in the last 3 years. During that short period of time both the automobile traffic and the motor truck traffic has increased 66 per cent, or an increase of about 22 per cent a year.

While the average traffic shown in the foregoing tables gives a fair indication of what is happening all over the state, there are a number of main highways that are tributary to the larger cities and manufacturing plants and the seaboard, where the traffic, and especially the truck traffic, has increased very much more rapidly. This is shown by the accompanying comparison of the traffic at 15 points on main trunk lines:

AVERAGE DAILY TRAFFIC

		Total horse	Automobiles	Trucks	Total vehicles
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	(1918)	56	1,119	83	1,258
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	(1918)	66	1,575	112	1,753
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	(1918)	65	1,195	85	1,345
[illegible]	[illegible]	[illegible]	281	[illegible]	[illegible]
	(1918)	314	873	64	1,281
[illegible]	[illegible]	[illegible]	334	12	[illegible]
	[illegible]	[illegible]	[illegible]	67	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	(1918)	28	1,379	179	1,586
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	(1918)	38	1,484	238	1,760
Concord-Harvard ..	(1915)	57	238	16	311
	(1918)	55	523	107	685
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	144	[illegible]
Fall River	(1915)	326	763	61	1,150
	[illegible]	[illegible]	[illegible]	403	2,751
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	(1918)	134	1,606	203	1,943
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	(1918)	54	2,062	135	2,251
Salem	(1915)	144	1,113	181	1,438
	(1918)	51	2,636	224	2,911
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	(1918)	19	668	19	706
[illegible]					
	(1915)	301	...	212	...
	(1918)	215	...	398	...

The counts on two different roads in Concord show the amount of traffic that was put onto the roads by the building of an army cantonment. Camp Devens is located at Ayer, about 36 miles out of Boston, and the change in the traffic on these 2 roads is undoubtedly due to the presence of that cantonment. The 2 roads together had 35 trucks in 1915, but 3 years later, in 1918, they had 345, or over 10 times as many. The total number of automobiles was less than 900 in 1915, and over 2,000 in 1918, 3 years later.

The last count, Revere and Saugus, shows traffic on 2 roads, one of them being recently opened, and the counts merged in order to show the increase in truck traffic going to the city of Lynn, which is a large manufacturing city situated about 11 miles from Boston. Here the number of trucks had increased from 176 a day to 398 a day in 3 years.

The above figures show very clearly what is going to happen in the immediate neighborhood of our big cities on the main truck lines connecting large industrial centers with each other.

Undoubtedly a good deal of this traffic was due to war conditions, the roads being used by army trucks and by more than the usual number of commercial vehicles because of the congestion on the railroads.

On the other hand, the traffic counts also show that this increase in heavy truck traffic is 2 or 3 times greater on main through lines connecting important cities together that are within 40 miles of each other, and that the truck traffic there has increased much more than it has on the through routes in the country districts.

The Highways of the Future.—It is perfectly clear, however, that the highways of the future will have to be constructed wide enough and strong enough to carry with reasonable safety the constantly increasing number of vehicles that will go over them; that a highway will have to be provided that can stand up under the constantly increasing traffic in motor trucks.

This means that the old waterbound macadam roads, which were built 5 or 6 in. thick on ordinary soil, will not last or be economical even with a surface treatment, if they are on a main route that has to carry an average of 50 to 100 heavy motor trucks a day.

A well-drained foundation will be necessary even for bituminous macadam, unless the subsoil is porous and well-drained sand or gravel, and even then it may be found more economical to build a more expensive and stronger pavement on main routes that have a large amount of heavy truck traffic.

Colorado Proposes Establishing Rates for Motor Truck Carriers

In Colorado truck carriers, when in competition with the railroads or street railways, are classified as public utilities subject to the jurisdiction of the State Public Utilities Commission. The steps taken to establish bases of rates for these motor truck carriers are outlined by Mr. C. E. Neil, Rate Expert of the Colorado Public Utilities Commission, in a recent issue of The Commercial Vehicle, from which the matter following is abstracted.

Immediately after the organization of the State Highways Transport Committee, the complete data and information of the Public Utilities Commission were placed at the disposal of the committee. The rate department of the commission has since that time been working with the committee on the question of rates in an endeavor to evolve an equitable system to attract both the owners of trucks to placing their vehicles in public service and the shippers of commodities to transporting their goods via rural motor express.

As a temporary expedient, and as a measure to insure the prompt installation of motor truck service, the suggestion was made to operators that a basis predicated on using the first-class freight rate plus the first-class express rate and dividing the product by two would be at such a plane as to enable the movement of truck traffic.

At the present time investigations are being made to ascertain a more permanent basis of rates which can be placed at the disposal of the operators. The public utility law of Colorado requires that a certficate of public convenience and necessity be obtained by each truck carrier desiring to operate in competition with railroads or street railways. It is through this medium that the commission is able to keep a close check on the operations of such carriers.

Motor transportation rates, like freight rates, must be predicated with the consideration of the prime factors dividing the handling of traffic, one known as the terminal service and the other the transportation or haulage service. The charge for the former is fixed, while that for the latter varies with distance.

Many factors enter into motor express rates, most of which are analogous to the factors entering into the making of freight rates. Chief among these are: Cost of service; value of service; length of haul; volume of traffic; what traffic will bear; value of service to shippers; bulk; value of goods; terminal expenses, and empty hauls. It is, of course, an impossibility to so finely weigh these different factors as to determine upon an exact rate which will properly include all cases, or to determine accurately the relative importance of each factor.

Patrol Method of Road Maintenance as Employed in Maine

During the last three years the State and State-aid highways in Maine have been maintained by the patrol method, the State Highway Commission having entire charge of the work. The Commission hires the patrolmen and pays them direct from the Highway Department. All reports are made to the Commission. At the end of the season a report is submitted to each town showing just what has been accomplished so that they can see how their maintenance money has been expended. An interesting description of the Maine patrol system was given by Mr. Paul D. Sargent, Chief Engineer of the State Highway Commission, in a paper presented Dec. 12 at the meeting of the American Association of State Highway Officials. The following is quoted from the paper.

Selection of Patrolmen.—In the hiring of patrolmen we first ask the municipal officers of each town to recommend three men who in their judgment would be suitable to do the work. We had a brief statement with respect to each man as to his age, height, weight, health, nationality, and previous experience, also as to his location with respect to the road to be patrolled.

Our supervisor then went into the town, interviewed the men, and hired the man who seemed to be best fitted to do the work. Frequently none of the men recommended by the municipal officers was found to be suitable and then the supervisor hunted around until he found someone.

Patrolmen's Reports.—Instructions quite in detail are sent to the patrolmen each spring and they are visited as often as once in two weeks by one of our supervisors. They are required to make a report once a week showing what they have done each day, together with the condition of the weather. In this way the supervisor, who has charge of about 25 patrolmen, is able to keep in touch with the work. The reports after being looked over by the supervisor are sent to the Highway Commission office where the superintendent of maintenance finally reviews them and places them on file.

Our patrolmen show on the weekly reports the amount of time which they have spent each day on the improved road and on the unimproved road under their care. In this way we are able to control the expenditure and to keep it in about the right proportion on the different classes of road. Under our law towns are obliged to pay toward the maintenance of State highways $60 per mile per annum, provided the expenditure amounts to that, and on improved State-aid roads $30 per mile per annum, the State paying the balance.

Wages of Patrolmen.—Patrolmen are paid once a month and the time which they send in at the end of the month has to agree with the weekly reports previously filed both as to time worked and as to classification or distribution of the labor.

In 1916 patrolmen were paid $75 per month. For this they furnished one horse weighing not less than 1,200 lb., a drop-axle wagon, and the necessary hand tools, and a drag built for one horse. During the last two years we have allowed patrolmen to use two horses more or less. At the present time one-third to one-half of our patrolmen are hired with two horses and the men who regularly work one horse are authorized to employ an additional horse to do dragging. During the present season we started in paying patrolmen with one horse 44 ct. per hour and with two horses 55 ct. per hour. Due to abnormal labor conditions prevailing and to stabilize our patrol force, we made an agreement with every patrolman when we hired him this year that we should pay him only 95 per cent of his wages each month. The remaining 5 per cent was to be held back until the end of the season and to be paid him in a lump, provided he remained through the entire season. In case a man was discharged on account of unsatisfactory work he was not to receive this 5 per cent. We have had very few resignations and it has been necessary to discharge but a very few men. On Sept. 1 we increased the patrolmen's rates of pay to the following amounts: 50 ct. per hour for a man with one horse and 60 ct. per hour for a man with two horses.

Cost of Maintenance by Patrol System.—During the year 1916 we employed 373 patrolmen and had under patrol 3,466 miles of road. The total expenditure was $286,399 and the average expenditure per mile was $77.43.

During 1917 we employed 437 patrolmen caring for 3,705 miles of road. The total expenditure was $432,716 and the average expenditure per mile was $117.19.

During the present season we have employed 480 patrolmen caring for 4,250 miles of road. The total expenditures will be about $500,000, making an average expenditure of a little over $140 per mile. These increased costs are due to the increased cost of labor and material. A little rough figuring indicates that our labor costs have averaged about 34 per cent over 1917, which would give us roughly an average cost per mile for maintenance this year of $157.

We have approximately 100 miles of State highway which we surface treat each year, using Tarvia B and sand. The cost of preparing the road, making the surface application, and then keeping the road patched and the shoulders in shape through the season has averaged during the last 3 years from about $650 per mile in 1916 to $850 to $900 per mile through the present season. These figures are all included in the averages which have been given above.

Motor Trucks in Patrol Service.—During the season of 1918 we have had four 1-ton trucks in patrol service. These trucks have replaced from 2 to 4 horses under the old scheme. In other words, we have combined 2, 3 or 4 patrol sections and have employed a truck driver with 2 to 3 helpers. The longest section under such patrol arrangement was 33 miles of bituminous macadam. We have had several sections of tar surface treated gravel cared for by the truck patrol. Our observation is that these sections of road have been better cared for than in any previous season and we plan to operate the trucks another year. The trucks are not heavy enough, however, to draw a drag and when it has been necessary to drag the shoulders we have had to employ teams.

A comparison of the cost of patrol maintenance by trucks and by horses may be interesting. On one of our State highways, 55 miles in length, in the season of 1917 we employed 4 patrolmen, each with one horse and with more or less extra help. The total cost for horse and man labor in patrolling this 55 miles of road during the season was $10,712. During the season of 1918 we substituted two Ford one-ton trucks. The cost of labor, including operating expenses of the two trucks and an allowance of $2 per day for each truck as a depreciation charge, figures $8,098. This shows a saving of about $2,500 in the maintenance of this 55 miles of road, and the road has been much better taken care of than previously.

Figures on another section of State highway 34 miles in length are as follows: In 1917 the total cost for labor and horses for the entire season was $4,392. During 1918 the same road was maintained with one truck and three men at a cost of $2,705, including the depreciation and maintenance of the truck. This shows a saving of almost $1,700 on this section of road.

On one other section, 20 miles in length, where in 1917 we had two patrolmen, each with a horse, our expense for the year, including extra help, was $3,600. This year the same section has been maintained with one truck and two men beside the foreman and the total expense for truck and labor has been $3,806. This is the only section which shows an increase over the cost of maintaining with horses. It is fair to state that in this section was a piece of road 1.7 miles long which was not quite finished as to construction in the fall of 1917. The patrol gang this year finished the surface of this road, which needed considerable patching, dragging, regravelling. The condition of this road, as already indicated with respect to the other sections, is far above its general condition one year ago.

It will be seen from these statements that our experience with trucks for maintenance has been very satisfactory.

In making the above comparison it should be borne in mind that labor costs this year were at least 30 per cent higher than they were in 1917.

Proposed Uniform Law for Regulation of Speed and Dimensions of Motor Trucks*

By GEORGE M. GRAHAM

Chairman National Motor Truck Committee of the National Automobile Chamber of Commerce

As a basic proposition we submit that highways should be the servant of transportation, not its master. The truck has made its place. It has proved its adaptability to modern transportation problems. Civilization will lose unless means be found for its expanding application. Restrictions, prejudices and petty objections must not be permitted to stand in its way, for it presents possibilities that are too great to be side-tracked for temporary considerations.

Those who admit no place for the truck stand opposed to the spirit of the times. Those legislators who vote against trucks feeling that they are serving the interest of the farmer, should be reminded that actually they are working against the pocketbook of the farmer. It is a fact not yet generally known that haulage of farm product by motor truck is cheaper than haulage by team, as shown by the following table presented by Frank Andrews of the Bureau of Crop Estimates, of the Department of Agriculture:

	Horse and team Per ton mile.	Truck Per ton mile.
Wheat	$0.30	$0.15
[illegible]	[illegible]	0.15
Cotton	0.48	0.16

Manufacturers Agree on Uniform Truck Law.—As manufacturers we know that we must build trucks to weight, speed and tire size that will do least harm to present roads. The foremost men of the industry, recognizing the difficulties involved, have given close thought to the question of dimensions. Frequent meetings have been held in Washington to discuss the subject in detail. Compromises and adjustments have been made, and we are now in agreement on a bill which we should like to see enacted into law by all the legislatures of the United States. It was high time for such concerted action, and we wish to propose a combination of necessary fundamentals, equitable legislation, efficient administration and proper construction.

It is entirely possible that after the war short-line railroads will be a thing of the past, not only because the motor truck can deliver goods over short hauls in quicker time and at a reduced shipping rate, but because it saves labor and time by delivering goods to the consignee's door. Add to this the fact that there is no intial expense in putting a line of motor trucks in operation, outside of the original cost of the trucks, as compared with the high cost of track building and railroad equipment.

Responsibility of Trucks for Damaged Condition of Roads.—I should like to raise the question of how far trucks are responsible for the present damaged condition of the roads. Are they unjustly accused in this respect? It is conceded that roads were never in worse shape, that many highways formerly famed for their perfection are now battered and filled with ruts and holes. But is this up to the trucks? A foremost expert on road building and maintenance makes the statement:

"Since the war started we have not been able to make repairs. Labor has been lacking, and there have been embargoes on road-building material. Where formerly in the spring we would have quickly filled the holes and patched the ruts, we have been unable to do so. Therefore, the roads have been permitted to remain smashed up. Once our maintenance system is restored, we shall be able to do away with a lot of the present trouble. But for the lack of this repair the present agitation against trucks never would have arisen."

In our investigation we have found the opinion almost general that most of the damage is done in the spring. Then the frost is still in the ground, and as it thaws the mixture becomes almost like jelly. The impact of the passing vehicle with the top crust of the road, unsupported as the latter is by any adequate foundation, results in more damage than could be inflicted in all the other months of the year put together. We admit this fact unhesitatingly. We have in our bill proposed a remedy for it in the shape of an embargo by which, on proper notice, any road can be closed to traffic by the local highway authorities for any vehicle weighing more than 10,000 lb. Such embargoes cannot cover more than 15 days in any one year.

Dimensions, Weights, Speed, Etc., in Proposed Uniform Truck Law. Height and width are not the major problems with which we must deal. We have fixed on 12½ ft. as the utmost distance between the road and the summit of the body, and 8 ft. as the greatest width of the body. We do not think these figures should be exceeded, and would cheerfully bow to laws so decreeing. Thus we readily dispose of height and width, but when we come to weight and speed we have much more to contend with.

It is not to be denied that the heavily weighted truck, running on solid tires and at high speed, causes damage. But it is not to be forgotten that both this weight and speed serve a highly practical purpose—the cost of carrying the load decreases in proportion to the number of tons carried.

As a general proposition it may be stated that as the size of the truck increases the cost of operation in relation to carrying capacity decreases. There are four principal reasons for this: (1) The cost of manufacture of a truck does not increase in proportion to the carrying capacity; (2) the so-called fixed charge, or overhead of operation, does not increase in proportion to carrying capacity; (3) the actual operation cost does not increase in proportion to carrying capacity; (4) the weight of the truck itself does not increase in proportion to carrying capacity.

From an economic standpoint this is most important. Truck owners have a right to operate their trucks to the highest limit of economy and efficiency. They should be permitted to run the heaviest possible truck made necessary by their haulage problems, and roads should be made equal to the burden as speedily as possible. To take any other position is to legislate directly against an increasing army of motor-truck users.

There are not less than 550,000 trucks in use in the United States. It has been estimated that farmers alone will apply to the highways 2,000,000 more trucks within the next 10 years. The possibilities in all other lines of activity are so many and so varied that the whole subject of truck legislation must be approached with justice and vision.

Our plan for a uniform truck law calls for permission to operate a vehicle whose gross load is 28,000 lb. It also provides that the Highway Commissioner can reduce this limit to 24,000 lb., where it can be shown that the roads will not stand more than this weight. He also has the option of increasing above 28,000 lb., where highly improved roads make this possible.

Table I provides for license fees, three kinds of speed according to section traversed, maximum weight and the load per inch width of tire. With the considerations of license fees I have not to do. The load per inch width of tire, after due consideration, was fixed at 800 lb. throughout, whether solid or pneumatic tires be used. The speed and fees vary as the total load.

An examination of the weight of vehicles made by some 40 manufacturers show that within the 4,000-lb. class will fall vehicles rated to carry ½-ton and ¾-ton loads; 8,000-lb. class, 1- and 1½-ton loads; 12,000-lb. class, 2-ton loads; 16,000-lb. class, 3- and 3½-ton loads; 20,000-lb. class, 4- and 4½-ton loads; 24,000-lb. class, 5-ton loads, and within the 28,000-lb. class, 6- and 7-ton loads.

If it be said that the maximum weight should be put to as low a point as possible in order to deal with probable overloading, attention should be directed to the penalty prescribed in the bill—a penalty made the more easy of infliction since the bill provides for a plate placed on the truck, said plate to show a gross weight of vehicle and load. Any truck carrying more than this weight becomes

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*[illegible] the [illegible] Convention of the American [illegible] Highway [illegible], the Highway Industries Association.

TABLE I. WEIGHTS, SPEEDS AND FEES SUGGESTED FOR PROPOSED UNIFORM TRAFFIC LAW

Character of Vehicle			Fees		Speed Limits*				
Letter Reference	Type of Tires, Etc.	Maximum weight vehicle and load	Covering all charges including property taxes	Covering all except property taxes	In open country Miles	Through cities, towns and villages Miles	In the business part of cities, towns Miles	Load per inch width of tire	
A	Passenger or light commercial, pneumatic tires...	6,000	$ 0.60	Per horsepower $ 0.40	30	20	15	800	
B	Other pneumatic tired	4,000	30.00	Per annum: 15.00	25	20	15	800	
B	Other pneumatic tired	8,000	45.00	22.50	25	20	15	800	
B	Other pneumatic tired	12,000	60.00	30.00	25	20	15	800	
B	Other pneumatic tired	16,000	75.00	37.50	25	20	15	800	
B	Other pneumatic tired	20,000	90.00	45.00	25	20	15	800	
B	Other pneumatic tired	24,000	105.00	52.50	25	20	15	800	
B	Other pneumatic tired	28,000	120.00	60.00	25	20	15	800	
C	Having solid rubber tires	4,000	40.00	20.00	25	20	15	800	
C	Having solid rubber tires	8,000	60.00	30.00	25	20	15	800	
C	Having solid rubber tires	12,000	80.00	40.00	20	18	12	800	
C	Having solid rubber tires	16,000	100.00	50.00	18	15	12	800	
C	Having solid rubber tires	20,000	120.00	60.00	16	15	12	800	
C	Having solid rubber tires	24,000	140.00	70.00	15	15	12	800	
C	Having solid rubber tires	28,000	160.00	80.00	15	15	12	800	
D	Commercial passenger	6,000	1.60	Per horsepower .80	[illegible]	20	15	800	
D	Commercial passenger	7,000	40.00	Per annum 20.00	[illegible]	20	12	800	
D	Commercial passenger	8,000	50.00	25.00	25	20	12	800	
E	Motorcycles		10.00	5.00	30	20	15		
E	Motorcycles, side car...		6.00	3.00					
F	Trailers or semi-trailers, with solid rubber tires..	4,000	20.00	10.00					
F	Trailers or semi-trailers, with solid rubber tires..	8,000	30.00	15.00					
F	Trailers or semi-trailers, with solid rubber tires..	12,000	40.00	20.00					
F	Trailers or semi-trailers, with solid rubber tires..	16,000	50.00	25.00					
F	Trailers or semi-trailers, with solid rubber tires..	20,000	60.00	30.00					
F	Trailers or semi-trailers, with solid rubber tires..	24,000	70.00	35.00					
F	Trailers or semi-trailers, with solid rubber tires..	28,000	80.00	40.00					
F	Same with iron tires...								Double the above rate for Class F.
F	Same with pneumatic tires								Three-quarters of the above rate for Class F.
G	Traction engines, tractors, etc., not loaded.		30.00	25.00					
H	Electric								Two-thirds of the fee charged gasoline vehicles of equal weight.
I	Animal drawn			1.00					For one horse or its equal....800 lb
I	Animal drawn			2.00					For two horses of their equal..800 lb
I	Animal drawn			4.00					For four horses or their equal.800 lb
I	Animal drawn			6.00					For six horses or their equal..800 lb
I	Animal drawn			8.00					For 8 horses or their equal....800 lb
I	Animal drawn			12.00					For 12 horses or their equal...800 lb.
J	Publicly owned								No charge; maximum speed, maximum weight and load per inch width of tire to govern each similar class of vehicle as prescribed in Classes A, B, C, F and K
K	Registration tags or markers issued to manufacturers and dealers in motor vehicles or trailers			25.00					For first two sets—$12 for each additional set.
L	Registration tags or markers issued to manufacturers and dealers in motorcycles			20.00					For first two sets—$5 for each additional set.
M	Chauffeurs' licenses			2.00					
M	Operators' licenses			2.00					For operators good until revoked
N	Duplicate licenses			.50					For each duplicate set.

*For distances not to exceed ¼ mile greater speeds may be attained in order to permit one vehicle to pass anothe

liable to the penalty. The question, therefore, becomes one of proper administration.

Motor Truck Economical in Steel Consumption. The war has made opposition to waste a national policy. It should, therefore, be remembered that the motor truck is highly economical in its consumption of steel, as compared to its carrying capacity. The steel required for the average railroad freight car is 25 tons; for the average locomotive and its tender 150 more tons must be allotted. A 2-ton motor truck requires 1½ tons.

The ton-mileage of a freight car per day is 800, 40 tons average load and 20 miles per day. An easy average for the 2-ton motor truck is 200 ton-miles, 2-ton load and 100 miles per day. Therefore, the four 2-ton trucks can do more work per day than one freight car. Trucks also deliver direct from shipper to consignee.

To build 50,000 steel freight cars and the 1,250 locomotives to draw them will require 1,437,000 tons of steel. Only 300,000 tons of steel are necessary to build 200,000 2-ton trucks capable of doing the same amount of work. There is a saving of 1,137,000 tons of steel.

Considered from the standpoint of national wealth and prosperity, does not this saving, plus the time saving in favor of motor trucks, make insignificant the cost of repairing possible damage to the roads.

Increased Road Building in Michigan Despite War Time Handicaps.—During the fiscal year ending June 30, 1918, only 793 miles of state reward roads in Michigan were approved by the State Highway Commissioner. This was a decrease of about 25 per cent over the mileage of the previous year. However, during the five months, June 30, 1918, to Nov. 30, a total of 560 miles of road was accepted, as compared with 391 miles during the same period of 1917, a 43 per cent increase over the previous year in spite of all war time handicaps.

Convention of Virginia Good Roads Association.—The 8th annual convention of the Virginia Good Roads Association will be held at Murphy's Hotel, Richmond, Va., Jan. 14, 15 and 16. Among the subjects to be considered are providing means for the construction of the state highway system, established by the last General Assembly; larger appropriations for state aid for building the county highway systems; better provision for the improvement of district and neighborhood roads; greater appropriations by the federal government for federal aid to highways; the establishment of a national highway system, to be built and maintained by the national government, and the number and routes of such highways through Virginia; the extension of motor parcel-post routes in the rural districts; the most desirable and satisfactory types of construction adapted to modern traffic conditions; the question of increasing the tax for the construction of the state highway system, or the issuing of bonds for that purpose; proper regulations for the use of our improved highways; the proposition to levy a tax on all wagons and other vehicles similar to that paid by motor vehicles; and many other matters concerning the construction and maintenance of roads and bridges in this state.

C. B. Scott, Richmond, Va., is Secretary-Treasurer of the Association.

Experiences at Worcester, Mass., in Public Work Construction by City Forces

By ALBERT T. RHODES.

Much discussion has been given to the matter of contract labor as opposed to the municipality doing its own work. As former Street Commissioner of the city of Worcester, and after observing work throughout the eastern half of the United States, I am more than ever confirmed in my opinion that the municipalities' forces, if properly organized, can bring about better, more durable, results than by contract work. In the matter of work being done by the city itself, I am speaking only through my experience as former Street Commissioner of the city of Worcester, previous to which time I had been Superintendent, and had also done most of the estimating for one of the largest construction firms in that city. I was extremely surprised on taking up my new duties as Street Commissioner, after leaving this construction firm, to find on examination of the cost sheets that the city was doing work, in a great many instances, cheaper than my cost figures in the construction firm.

After making this statement of course the question immediately arises as to the overhead in regard to the municipality doing its own work, but there are other features which enter into the consideration of the matter which far overbalance any items of overhead expenditure which may enter into the proposition. For instance, the city was equipped with labor saving machinery in a much better manner than any of the contractors who were doing business in that vicinity. In fact, at times when a change of work allowed certain pieces of equipment to be idle, there was generally a considerable demand from contractors, and considerable money accrued from the rental of these machines at times when they were not needed for the city's use. In the matter of stock alone I believe that more saving was generally effected than would accrue to the contractor alone as a percentage profit on the work.

The theory is often advanced that city laborers do not work as well as contract laborers. This may be so, but I have failed to observe it during the past year and one-half to any degree, and any difference in loss through the labor end of the proposition is more than balanced up by the saving of the percentage of profit to the city by the purchase of supplies in large quantities, at low rates, and by the use of labor saving machinery.

In the matter of stock alone we will consider several items of interest. In December and January of last year the city bought and received 500 tons of asphalt at $26.53 f.o.b. Worcester. At the time contracts would have been let for general construction work, this material had soared to the price of $40 per ton or better, and was hardly obtainable at that figure. Cement was obtained, 30 carloads in storage December and January at $2.20 per barrel. At the time general construction would have been in progress, and contracts would have been let, some of the materials was bringing in the open market over $3 per barrel. Brick bought at $11.53 f.o.b. Worcester was selling for $21 per thousand at the yard. The city placed an order for tar for their 1918 season's supply, previous to Jan. 1 for 8½ ct. per gallon. The price jumped to from 12 ct. to 18 ct. per gallon the following season at the time the material was to be used. Road oils were in storage at a price of 6.49 ct. per gallon and the season opened with prices from 11 ct. to 18 ct. per gallon for the material, with none in the city even at that figure. All the paving blocks that could be obtained of the size usually used by the city of Worcester were bought and placed in storage in December, 1917, and January, 1918, at 1917 prices.

A machine steam-roller scarifier was purchased which would in all probability do the work of 100 men in a day in the matter of picking up any old macadam or hard gravel roadway. However, the greatest inducements today for cities to do their own work are those brought about by natural causes. Whereas 5 years ago it was an easy matter to obtain, in the winter time, a force of laborers for the handling of snow and ice, today it is a very serious proposition no such floating element of labor exists. The tendency today is toward the cleaning of the highways of snow and ice during the winter months to increase the facilities of motor truck transportation, also the general cleaning of snow and ice throughout the city requires at times a heavy force of men, which, if they were not on hand, would put the city in an extremely difficult position as far as travel on their highways is concerned. Consequently, it is absolutely necessary to have at hand as much of a working force as is usually worked through the summer months on construction work. In addition to this, most cities have taken up the collection of ashes and rubbish. In the winter time, naturally, there is an increased amount of ashes to be removed, requiring more help for that purpose. In the summer time naturally this work slackens off, leaving the men free for the construction work, street cleaning, maintenance, etc.

In addition to these above items there is much work which can be done in a city in the winter time, which must of necessity be completed at some future time, but which might not be chosen as necessary work to be done on account of the expenditure of money it would entail. This matter that I am referring to is the matter of the country or outlying roads of a municipality which have never carried anything other than a roadway for the traveling of vehicles. On these roads, sidewalks will eventually have to be laid, extending the work of the highway to its outside limits. One of the most vital reasons for accomplishing this work ahead of the construction of the residences bordering on the highway, lies in the fact that should proper construction occur and the lawns of abutting property owners encroach upon the highways, damages may be, and are, collected in a great many instances on account of cuts or fills.

Other work which may very properly be done in the winter is the gravelling of the highways in the outer sections of a municipality. This may be accomplished regardless of the fact that snow and ice are on the street. If the snow is light it may be pushed to either side with a road machine and gravelling continue the same as in the summer months.

Another feature of winter work used a great many times in connection with this graveling of country roads is the use of a stone crusher in a gravel bank. The screen is removed from the stone crusher and all the material coming from the gravel bank is passed through the crusher and into the bins without separation, in this way making use of all the available road metal which is contained in the stones. It has been my experience that this feature added enough in value and saving to more than overbalance the expense of any handling through the crusher, as the material is all loaded into bins for delivery into carts from the chutes without any further shoveling.

In addition to the above the crusher is also made use of in providing a large storage pile of crushed stone for the next summer's use. It may seem that this is adding extra expense to the cost of producing the crushed stone on account of the extra handling from the storage piles at the time the material is used in the summer; but when it is realized that the material is immediately available for use, without the difficulty of shipping it into the city by freight, and it will be seen that the extra cost in handling would be eaten up generally by freight charges—also the municipality is able to get the stone in quantity very quickly, in this way facilitating speed of construction on whatever work is in progress. The handling is also taken care of by steam shovels generally, and one shovel has been known to load 12 teams and three trucks in from 25 to 45 minutes.

Cindering of sidewalks in the outer districts is also taken care of in the winter season, at which time, generally, most factories are more than anxious to get rid of their cinders to anyone who will take them away, while in the summer time more or less difficulty is experienced in obtaining this product.

It will be seen from the above that it is practically a necessity to keep a working force and organization together at the present time, because it is absolutely impossible to pick up the old floating labor winter and summer in any municipality. If the workmen have been educated in their various lines of work, the necessity of assistant inspectors is eliminated and the tendency of the entire work is to use the best of materials in proper proportions and produce the best possible results.

The value of the results of this system can be shown by an inspection of the streets and by reference to the cost sheets. The granite paving done practically by city labor has stood the test of time, some of the oldest pieces being from 14 to 20 years of age and in excellent condition today.

In 1913 and 1914, 3-in. tar penetration work cost from 45 to 55 ct. per square yard. Granolithic sidewalks with cinder fill underneath ran from $1.50 to $1.80 per square yard. 6-in. cement grouted granite block paving on 5-in. concrete base cost less than was generally figured on the engineer's estimate of $3.25 per square yard, including all digging and preparation of the bed; and in only two instances, if I am rightly informed, did the cost exceed $4 per square yard up to the fall of 1917.

"The Cities' Part in Readjustment Is Creating Opportunities for People to Work"

The necessity of cities undertaking immediate public works construction to supply jobs for soldiers and war workers is pointed out in the December issue of New Jersey Municipalities, the official organ of the New Jersey State League of Municipalities, from which we quote as follows:

The tremendous task that faces us now is rather a task of readjustment, of getting from a war basis to a peace basis; of demobilizing our armies, closing our munitions and other war-order factories, reopening and enlarging our peace-time industries, picking up and developing our dormant projects of public works.

The principal danger in "readjustment" is that we shall not catch the new stride in peace-time industry and public works quickly enough to open up jobs for all the men and women rapidly released from the army and navy and war industries. Coming as demobilization does, at the beginning of the winter months, when construction is ordinarily at low ebb, when the demand for farm labor is lowest, and when the railroads are uncertain as to their future program or fate, we are unpleasantly confronted with a "labor glut." It is a sad commentary on American idealism that, so far, in speech and print, the fear most commonly voiced in this connection is the fear that the labor that is thus left unemployed will raise the red flag, and riot and destroy other people's property. We ought to be concerned about protecting property, but we have need to be far more concerned about protecting these people—the men and women who have made cartridges and trench coats and machine guns, or actually worn khaki and stopped German bullets—from unnecessary unemployment.

It will help us considerably in performing our part in "readjustment" to stop thinking of labor as a commodity and think of it as people—peoples whose main need is a place of employment where they can earn their own living.

The cities' part in "readjustment," then, is creating opportunities for people to work.

This will not be difficult. Thousands of dollars' worth of improvements and construction that have been held up during the war may now be proceeded with. Building restrictions are off. Manufacture of building materials is again proceeding. The Capital Issues Committee is favorable toward municipal issues, and the bond market is good.

The principal need is to go to work now. There are really only two things, aside from ordinary inertia, that stand in the way. The first is the greater ease of pushing construction in spring and summer weather. This must not interfere with immediate action. The winter has been open so far, and even the ordinary probability of less favorable weather ahead must not stop us from beginning work immediately. Men need work now.

The second deterrent is the natural business sense which makes an executive hesitate about buying construction materials at high prices when he knows the market is soon going down. That is unfortunate indeed, but it must not interfere with the immediate starting of work. Men need work now. Whatever additional expenditure for materials is entailed, must be regarded as one more contribution to winning the war.

Cost of Road Work in New England in 1918

The cost of road work (construction and reconstruction) in New England in 1918 was 50 to 100 per cent higher than in the previous year, according to a paper by Col. Wm. D. Sohier, presented Dec. 9 at the meeting of the Association of State Highway Officials. The increase in cost of maintenance was probably very nearly as large. The two main causes of the increased cost of the work were ascribed to: first, increased wages, and second and at least equally important, to the inefficiency and instability of the labor. Extracts from Mr. Sohier's paper follow.

Inefficiency of Labor.—In the states where there have been large cantonments, as in Massachusetts, where war work was going on, or shipbuilding, labor conditions have been very much disorganized; the men were constantly leaving to secure a higher wage offered by contractors working on war munitions or war plants or cantonments or shipbuilding on a percentage basis.

This is well illustrated by the facts given by an experienced contractor at one of the places where the Government was doing the work on a percentage basis, where it was absolutely essential that the road work should be done as soon as possible.

This work upon roads occupied 13 weeks toward the end of 1917. During that time 1,380 men were employed and actually put at work in order to keep an average force of 430 men actually working.

It cost very nearly $4 to do the same amount of work which would have been done three years before for $1. For instance, formerly in unloading broken stone from the cars, 4 men could easily unload 4 cars a day, each car holding an average of 33 tons. The men were paid $2 a day. In other words, it cost $2 to unload 33 tons of stone. In the fall of 1917 it required 16 men a day to unload 8 cars holding 33 tons each, and each man was paid $4 a day. In other words, it cost $8 to unload 33 tons of stone, where it formerly cost $2. During the 8 weeks that the stone was being unloaded, there were 380 individuals who actually were on the payroll and came to work, it being necessary to employ this number of men in order to keep 16 at work on unloading. Hence, it is to be seen that wages doubled and labor was only half as efficient.

The average throughout the New England States, however, was not nearly as bad as this, although many Massachusetts contractors and engineers have said that the increased cost was very largely due to inefficiency rather than to the prices paid for labor.

Comparison of Increased Costs of Highway Work.—While the cost of labor, team, materials, etc., has been constantly increasing year by year for some time, not only because of an increase in the amounts paid but also because of shorter hours of labor in many states, the work of 1917 and 1918 has been very much more expensive than in 1916 because of war conditions.

The cost of maintenance in all the New England States has practically increased from 50 to 75 per cent, unless possibly in Connecticut where there was a considerable increase in 1917, so that in 1918 the cost increased only 20 per cent on labor items.

In most place sthe cost of construction or reconstruction has increased from 75 to 100 per cent or even more. In a few of the country districts the cost of the work has not increased so much because local labor and teams were used when they were not urgently needed on the farms. Also, the patrolmen and men employed on the maintenance of the main roads are more permanent as they generally are men who live in the locality.

In 1916 laborers were paid $1.75 to $2 for an 8-hour day, in Massachusetts; in 1918 the pay on the average, except for local men, was from $3.20 to $4 for an 8-hour day.

Teams which in 1916 cost from $4.50 to $5.50 today, cost in 1918 from $6 to even $8 per day.

The cost of materials and freight also increased from 50 to over 100 per cent from 1916 to 1918.

Comparison of Contract Prices.—The following are costs for surfacing work [illegible] sections of state road in [illegible] and [illegible], Mass., for 1916 and 1918.

[illegible]

	1916.	1918.
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

[illegible] the 1918 [illegible] the increase over [illegible]

[illegible]

	1916.	1918.
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

The increase [illegible] items was [illegible] per [illegible]

Increased Cost of Maintenance.—The cost of maintaining [illegible] waterbound macadam or gravel roads on the main lines is well shown by the following table:

Town.	1916.	1918.
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1,177.[illegible]
[illegible]	[illegible]	[illegible]
Gardner (West)	487.80	1,188.63
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
Winchendon (Maple St.)	364.35	872.68

These roads have all been maintained by surface treatments of asphaltic oil and kept constantly patched.

A very considerable item in the increased cost is due to the increasing use of motor trucks and especially the heavy motor trucks carrying 3 tons or more on solid tires.

Motor Trucks and Car Shortage

During the car shortage last year one of the greatest sources of relief in the transportation of car materials for highway work was the motor truck. Some noticeable instances of this were cited by Mr. Clinton Cowen, State Highway Commissioner of Ohio, in a paper presented at the recent meeting of the American Association of State Highway Officials. In the construction of a concrete foundation the materials were shipped originally by rail to a point within two miles of the work. When freight shipments were suspended, not a day was lost before the contractor had in the service a small fleet of trucks hauling stone direct from the quarry some 15 miles from the site of the improvement. Another instance worthy of mention is where stone was hauled by rail about 6 miles to a point from which the average wagon haul to the road would be about 1½ miles. Terminal facilities became obstructed and it was necessary to resort to trucks, which was done and the work was carried forward with surprising economy and rapidity.

The elimination of one handling at the railroad, the ability to spread the stone almost perfectly by tilting the truck bed to proper angle and the general stabilizing effect on the work, enabling the contractor to use adantageously a greater gang of laborers, are some of the reasons why trucks may be used to an advantage on short hauls and even on moderately long hauls where roads are in condition for truck service. To the contractor a direct haul from the quarry means the saving of the cost of loading, demurrage charges and congested conditions that so often arise due to irregularity in railroad delivery.

Investigation to Determine Limiting Weights of Trucks on Highways.—The American Association of State Highways Officials at its Chicago meeting appointed a committee to confer with the Highway Industries Association for the purpose of getting a real engineering investigation of what will stand. The resolution provided that the committee should submit recommendations as to limiting weights of motor trucks to be used on the various types of highways. It was further resolved that the data for this recommendation be obtained from a study of existing data and also from real experiments on the different types of pavements and that the cost of the experiments be distributed among the states which are financially able to afford the expense of such investigation.

Convict Labor in Road Construction in West Virginia

For the past 4 years West Virginia has been employing a portion of its state prisoners on road work. Data on the maintenance of the prison camp No. 3 in Kanawha County, near Charleston, in 1917, were given by Mr. A. D. Williams, Chief Engineer of the West Virginia State Road Commission, in a paper presented Dec. 9 before the American Association of State Highway Officials.

The number of prisoners at the camp ranged from 12 in July to 28 in November, the average for the 12 months being 18. During the year 21,695 meals were served to prisoners and 1,959 meals to foremen and visitors. The average cost per meal was 13.96 ct. The total number of prisoners returned to prison was 16, and there were 7 escapes. Of the latter 4 prisoners were recaptured. The total number of days lost by sickness of prisoners was 126. The total prisoner days at the camp was 7,232 of which 4.027 were effective working days. The average daily cost of guarding and maintaining the prisoners was as follows:

	Per prisoner day.	Per effective day.
[illegible]	$0.1[illegible]	$0.272
[illegible]	.035	.063
Food	.456	.820
Equipment	.020	.036
Clothing	.044	.080
Tobacco	.027	.048
Garden seed	.003	.005
Transportation	.062	.112
Reward	.039	.069
[illegible]	.010	.018
Total	$ .847	$1.523

For the year there was a total of 36,243 hours' prison work, and a total of 27,840 lost or uneffective hours, which included 4.808 hours' bad weather, 7,991 hours' holidays and Sundays, 1,134 hours' sick, and 13,913 hours' camp duty.

The Legislature of West Virginia has for some years treated the penitentiary as a self-sustaining institution and made no appropriation for its maintenance, so the State Road Department in conjunction with the Board of Control and the county courts, have worked out plans to suit as near as possible each separate condition. When camp No. 1, March 23, 1914, was established the state undertook to guard, feed and clothe and supply the labor to the county at 75 ct. per day; on this it lost money. On May 20, 1914, camp No. 2 was established on the same basis at a per diem cost of 82½ ct. per day. This venture likewise was not satisfactory and proved expensive to the prison department. Camp No. 3 was established on the basis of camp No. 1 on July 6, 1914, and so operated for a period of time. Then the county agreed to assume all of the cost of maintenance, including transportation and guarding. On the first of the present calendar year, 1918, it became necessary to change the remuneration to the state, because of the high cost at the penitentiary and a new contract was made at camp No. 3, whereby the county bears all of the expense and pays the State 75 ct. per day. Of this 25 ct. per day is returned by the State to the prisoner, who in addition thereto receives 15 ct. per hour for all time over 9 hours per day. Camp No. 4 was established March 13, 1918, with 30 men, as a minimum, the county of Fayette paying all of the costs and paying the State $1 per day, of which the State pays the prisoner 25 ct. and the county pays the prisoner 15 ct. per hour for all overtime. Camp No. 5 consists of 50 men working from the penitentiary, the State boarding and clothing, the county furnishing transportation and guards; for this service the State receives $2 per day, of which 25 ct. per day and over-time is paid to the prisoner. In order to take care of some railroad improvement needed in the Benwood yards camp No. 6 of 50 prisoners is worked direct from the penitentiary for the B. & O. R. R., the railroad paying $2.85 and furnishing the men their dinners or noon-day meal. The State pays the prisoner 25 ct. per day. At the present time there is a total of 170 men working in the public road camps, and 50 men on the special railroad work, making a total of 220, or over 25 per cent of the prison population working as trusties or on the honor system.

Engineers for Highway Work*

By JOHN H. MULLEN,

Engineer and Deputy Commissioner, Minnesota State Highway Department.

The country evidently has become aroused to the need for highway improvement and is willing to spend millions of dollars for that purpose, provided there is assurance that the work will be properly handled. The public, however, does not know how this should be done, and has but a very hazy idea of the need for scientific organization and expert supervision of highway improvement. The engineer's work in France and the progress already made in this country has, to a certain degree, opened the eyes of the public in this respect, but there is little known of the careful investigations, the close study, the hard work and the infinite amount of detail attendant upon the successful prosecution of highway improvement. In the public mind, satisfactory results are generally credited to the contractors or superintendents of the work, who do not consider it unethical to advertise. This matter of publicity is very important and the people should be well informed on the management of highway affairs so that the engineers will be given due credit for their work.

Inadequate Pay of Highway Engineers.—Highway administration offers a great field for engineers, but this will not be developed unless it is possible to pay adequately for engineering services. This has not generally been done. Many states have worked up very efficient organizations and have been obliged to maintain them at a low expense on account of lack of funds. Some of these departments are held together through interest in the work and loyalty to the service, but this is a practical age, and if the proper kind of men are to be employed, if initiative is to be encouraged and efficiency promoted there must be a material reward. In the past few years it has been the experience of many engineers to have had charge of work on which the foreman and machine operators were drawing 50 to 100 per cent more pay than the engineer. Knowledge of this does not create respect for the profession by those employed on the work, nor does it increase the engineer's self-respect and confidence in his position of authority. Highway engineering requires as much training, experience and application as dentistry or the law and as a profession, is held responsible for the condition of the public highways which are the main arteries of business in the country, and which affect the individual and community more intimately than any other public work. Therefore in the light of fairness and good business this profession should also be recognized by proper compensation, otherwise it will be difficult to interest able engineers in the work.

Qualifications of a Highway Engineer.—The qualifications for a highway engineer do not seem to be generally agreed upon. It is frequently stated that this position requires only from 10 to 25 per cent technical knowledge and the remainder common sense. The natural consequence of such statements is to mislead the public and discredit the profession. It is true that the work requires the exercise of a great deal of common sense, but that is fundamental and true of any other important work. The highway engineer must have a ground-work of engineering knowledge, acquired through years of practical experience and study or by technical schooling. Without advanced technical training a man is greatly handicapped in engineering, but on the other hand, experience proves that men who have overcome this handicap are generally the most efficient. Highway engineering is a new science, in the process of development, and the man who can accumulate and systematize knowledge of this subject as it develops, will make a successful highway engineer, provided he has the preliminary training or engineering experience as a foundation. Actual training in this branch of work has not given engineering colleges much concern up to the present time, which, however, is not a serious matter, for traffic conditions have changed so radically in the past few years that the principles involved are entirely different. We are now at the opening of a new transportation era and the volume and importance of contemplated highway work calls for the special training of a large number of men. At the same time it is realized that engineering colleges are not generally equipped to give this training and therefor it falls upon the State Highway Engineers to lend assistance in directing the work of the students so that upon leaving college he will not have to serve such a long apprenticeship before taking charge of work.

To efficiently perform the duties of highway engineer requires not only technical qualifications, but also knowledge of public affairs, administrative ability, capacity for detail and the knack of handling men. The engineer, devoting all of his time to the work, is in the best position to study traffic conditions, and the economics of the situation, to advise the governing boards, and direct public sentiment along proper lines.

Placing Entire Responsibility for County Road Management on Highway Engineer.—There is a growing tendency, especially in the western states in which highway departments have been organized for several years, to place the entire responsibility for highway management in the county upon the highway engineer. Boards of supervisors have other interests demanding their attention and are placed in authority primarily to carry out public policy and to protect the public interests. It is not expected that they are qualified to direct engineering operations and they gladly receive the co-operation of the engineer if convinced that it is co-operation and not interference which the engineer offers. But an engineer should not assume such responsibility unless he is willing to apply a tremendous amount of study and work to the task. He must make a study of the present and prospective tonnage and passenger movement on the highways, of the availability of road materials and shipping facilities, and also of the economical types of road and bridge construction to meet the various conditions, and must inform the people of their needs in such a way that funds will be provided to carry on the work. A survey and accounting organization has to be worked up so that adequate and complete plans and supervision will be provided and comprehensive cost data made available, also that traffic and service records may be kept, and all factors governing road policy and administration tabulated and orderly arranged. There is practically no end to the detail connected with highway management if properly handled.

Too Rigid Standardization a Danger.—It may not be amiss at this time to go into the general policy of highway administration, and to caution the Federal and State authorities of the danger of too rigid standardization. General standards and principles must be established, of course, but individual initiative must be given full opportunity for development. Highway engineering is an art, not a trade.

Engineers from Army and Highway Work.—The prospect does not appear at all difficult for the immediate future, provided, however, that there is recognition of service and proper compensation, for then the profession will attract engineers who have been in military service, having previously had training and experience on railroads, highways or similar work, and whose military duty has forced a respect for detail and given an opportunity for handling men. Not only that, but their observation of the remarkably good road conditions in Europe, where the actual construction is nothing to speak of, but where the maintenance system is so amazingly complete, has awakened many of the engineers to the highway possibilities in this country and a consequent desire to participate in the work.

Co-operation of Highway Departments and Colleges.—[illegible] needs, but some means must be devised for training the large number of men who will be required to take charge of the tremendous amount of road building to be carried [illegible] the need for a combination of practical work with engineering studies and it would seem expedient for the various highway departments to co-operate with engineering colleges in this respect. This policy in general is in line [illegible] pared for the Joint Committee on "Engineering Education." An attempt has been made in Minnesota to follow a similar policy and a number of subordinate positions in the state highway engineering force have been filled during the summer months by university students, thus providing more efficient help on surveys and inspection and also giving the practical training so necessary to a complete education.

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*From a paper presented [illegible] at the meeting of the American Association of State Highway Officials.

Consideration of Health Important Factor in Determining Extent of Street Cleaning

Undoubtedly the primary reason for street cleaning is for the promotion of public comfort or convenience. The annoyance of dust to the users of the highway and to those adjacent, as well as damage to property, may well be considered primary, especially if coupled with its wet condition as well:

The second consideration, the aesthetic, may well have its weight, especially in elimination of rubbish, waste paper and larger debris which so offend our sense of propriety, but have little bearing on either health or comfort.

The third consideration, that of health, may be one which should warrant extensive and expensive work in this line. The Street Cleaning Committee of the American Public Health Association, Samuel Whinery, chairman, in its report of about two years ago, after diligent inquiries and collection of practical evidence, strongly inclined to the opinion that, while theoretically there might be much danger from unclean streets, from the health viewpoint, there was little or no positive evidence of such. This opinion was largely based on lack of definite information that those engaged continuously in street cleaning and similar work suffered any ill effects from what might be considered an abnormal or excessive exposure to those conditions supposedly deleterious to health from street dust and similar influences. At least one member of your committee, from experience with local spring and fall epidemics of influenza and bronchial affections when street cleaning in northern cities is interrupted, is firmly of the opinion that the consideration of health may be well ranked as the most important factor in determining the extent of such work. Lacking, as yet, any definite conclusive evidence, it may now be assumed that cleaning, such as to remove fine dust and mud which may cause such, offers a reasonable task in street cleaning for comfort and health. The aesthetic considerations in removal of unsightly litter, unless the same be considered a source of dust by pulverization, may be given consideration to the extent which the locality may warrant in expenses.

The change from dry to wet methods of cleaning now so increasingly evident, has a material bearing on the above considerations.—From the report of G. H. Norton, Rudolph Herring and R. C. Harris, submitted at the last annual convention of the American Society of Municipal Improvements.

Tractors Replace Horses in Michigan Road Grading.—Tractors have largely superseded horsepower in road grading operations in Michigan, stated Mr. Frank F. Rogers, State Highway Commissioner, in a paper presented at the Chicago meeting of the American Association of State Highway Officials. Tractors were not only used for hauling blade graders but ditching has been successfully done with the Ford tractor and flat board scrapers. A scraper was hitched to each end of the tractor which has a very short wheel base. The tractor then was moved across the road alternately forward and backward, but with a slight angle to the center line of the road so as to "cut over" the width of the scraper with each move. As the tractor moves ahead the scraper hitched to the rear end draws a full load up onto the road grade while the scraper hitched to the front end is backed to the ditch and vice versa. This way of using the tractor is said to be much more rapid than the work of two teams.

Special Assessments for Local Improvements

Information on the practice of cities in levying and collecting assessments has been collected by the secretary of the New York State Association of Mayors and other city officials. In reply to the questionnaire 163 cities reported on their methods of paying for the original pavement and for renewals and repavements. Of these 163 cities 73 reported that the entire cost of the original paving was assessed upon the property benefited; 24 reported that two-thirds of the cost was assessed on the area benefited, and 15 reported that half the cost was so assessed. Twenty-five cities bear the entire cost of the first street improvement.

Regarding repaving, 39 cities reported that the entire cost was assessed upon the property benefited; 15 reported that two-thirds the cost was so assessed and 16 reported 50 per cent assessed upon the property. Seventy cities bear the entire cost of the repaving.

In a paper presented at the last annual conference of the association, Mr. Nelson P. Lewis, Chief Engineer, Board of Estimates and Apportionment of New York City, after analyzing the replies to the questionnaire outlined the prevailing policies on other points, as indicated by the large majority of the replies, as follows:

The amount of assessment upon the frontage is limited to actual benefit, with a specific limit in a number of cities to one-half the land value, and in some cases to less than one-half.

The district of benefit where the assessment extends beyond the frontage is determined by council, but the number of towns reporting is too small to justify calling this a general policy.

Exemptions from assessment other than to Federal, state and city property are granted in no consistent way, not even in the same city. Even where it is said there are no exemptions, it is not unlikely that these can be secured if claims are effectively presented and pushed.

Pavement in street intersections is quite generally paid for by the city, although a substantial number of towns assess the entire cost.

Installment assessments are quite generally provided for; number of payments, usually 10, with interest at from 5 to 7 per cent.

Street railway companies are generally required to pave and maintain pavements between their tracks and rails and 2 ft. outside.

It is not improbable, states Mr. Lewis, that such agreement of practice as now exists is the result of more uniform statutes and the adoption by states of standard charters for cities of the same size. Entire uniformity cannot be expected, nor, perhaps, is it to be desired, especially in cities of greatly different size. Conditions in towns even of the same size vary greatly. Many of our cities are now undertaking great enterprise, involving large expenditures. They are also disposed to adopt policies which a few years ago would have been denounced as paternalistic or socialistic. Many of them have probably come to stay and during the period of readjustment following the war it is quite likely that our cities will be obliged to go even further than they have in these directions. The annual budgets for administrative purposes will increase, and it will be necessary to curtail such expenditures as are represented by contributions to what are commonly called local improvements. If a greater part or all of the cost of such improvements can be assessed, it will be necessary to do so.

It is often urged, continues Mr. Lewis, that street pavements are of at least as much general as local benefit, and that only a small part of the traffic in the streets has its origin or destination in abutting property. The relative amount of local and through-traffic will vary in different streets and within the same street from day to day according to weather conditions. This mixed traffic is a fruitful source of controversy, especially where the cost of the first pavement or any part of the cost of repavement is assessed against abutting property, owners of which protest against paying for improvements for the accommodation of what they call "alien" traffic.

It is true that, while certain other city improvements, such as sewers, are of peculiarly local benefit and can be used only by the abutting owners or those within the drainage area, the highways of the city are for the free use of all, even non-residents, but such general use in itself tends to make the abutting property more valuable. Good pavements result, therefore, in local benefit, and one principle which should be invariably recognized is that where there is local benefit there should be local assessment. There can be no street improvement which has been intelligently planned and executed which will not result in some local benefit, and it follows that there should also be some local assessment. No improvement, however large or small, will be of equal benefit to the entire city, and to distribute the burden of paying for it over the whole city according to taxable values is unfair, in that it is not placed according to benefit.

It is true that in small towns the benefit resulting from the paving of the few important streets extends to the entire community, and if the cost be met by general taxation the owners of the property on such streets will, by reason of its proportionately greater value, pay the greater part of the cost.

The principle of assessing the cost of street pavements, and perhaps that of pavement renewals, concludes Mr. Lewis, will probably have to be adopted more generally than it has been, whether such assessments be confined to the frontage or spread over a large area, in order that the borrowing power of the cities may be conserved and their annual tax budgets may be devoted more largely to the activities and enterprises which are unquestionably of general benefit.

American Association of Engineers Asks Chicago Aldermen to Increase Salaries of City's Engineers

The American Association of Engineers, through its Chicago Chapter, has requested the City Council of Chicago to increase the salaries of the technical engineers in the service of the city. In its letter to the Mayor and Aldermen, the association brings out the interesting fact that with very few exceptions, the salaries of the city's technical engineers have not been increased in 21 years. It is further pointed out that for the past 4 years it has been almost the general rule that the engineers are paid less than the journeymen working under their direction and for whose work they are responsible.

The salaries recommended by the association for the city's engineers follows:

Grade 1, Group C, $150 per month.
Grade 1, Group B, 170 per month.
Grade 1, Group A, 190 per month.
Grade 2, Group C, 205 per month.
Grade 2, Group B, 225 per month.
Grade 2, Group A, 245 per month.
Grade 3, Group C, 260 per month.
Grade 3, Group B, 280 per month.
Grade 3, Group A, 300 per month.

Grade 4 and above: not less than $5,000 and up, annually, according to specific position.

Wood Preserving and Tie Men Meet in St. Louis.—The 15th annual meeting of the American Wood Preservers' Association will be held at the Hotel Statler, St. Louis, on Jan. 28 and 29. The Tie and Timber Division of the St. Louis Chamber of Commerce has called a meeting of the tie producers of the country for the two following days to perfect a national organization. These meetings will bring together in convention in the same city and in the same week, the users and the producers of crossties. Advantage has been taken of this fact to correlate the programs of the two associations. The meeting of the American Wood Preservers' Association has been curtailed to two days with three sessions on Tuesday and two on Wednesday, concluding with a joint dinner with the National Tie Producers' Association on Wednesday evening, at which it is expected that one of the officers prominent in the United States Railway Administration will be the speaker. The sessions on Tuesday evening will be devoted to the consideration of the preservative materials situation. Wednesday afternoon will be given over to the consideration of the tie problem.

Summary of State Laws for Elimination of Railroad Grade Crossings

The Kansas Highway Commission sent letters to all State Highway Departments in an endeavor to secure information as to their laws and methods of distributing the cost of railroad grade crossing elimination. The information obtained was tabulated as follows by Mr. M. W. Watson, Acting State Highway Engineer of Kansas, in a paper presented Dec. 9 at the meeting of the American Association of State Highway Officials.

Alabama.—No definite procedure has been established. A number of grade crossings have been eliminated, but, as a rule, it has been where a change in location of the entire road was deemed advisable. The railroads have not been called upon to pay any part of such change. The railroads in Alabama have constructed overhead bridges and under passes at their own cost.

California.—Railroad grade crossings are under the jurisdiction of the Railroad Commission. Said commission has adopted no hard and fast rules as to the division of the cost of structures, but determine the same upon the equity attending each case.

The majority of the rulings on state highway work have been that the railroad companies when extending their lines over state highways where no railroad crossings had previously existed, the companies have been required to pay for the structures which were installed. Where the state highways have been built in new locations over railroads, the cost of structures has been divided equally between the railroad companies and the public.

Colorado.—Authority to abolish railroad grade crossings is vested in the Public Utilities Commission, and any work performed under their order would be at the expense of the railroads except where the State Highway Commission might co-operate. The Public Utilities Commission issue an order requiring that all approaches should be graded with a roadway 24 ft. in width and should be maintained on a level grade with the top of the rail for not less than 20 ft. from the center line of tracks to the approach to be constructed on a uniform grade of not to exceed 6 per cent from a point at least 20 ft. from center line of track.

Connecticut.—The elimination of crossings is in the hands of the Public Utilities Commission. The cost between the different parties interested is allocated in accordance with the condition prevailing in each particular case. There are no fixed percentages and the amounts vary between wide limits.

Delaware.—The matter of eliminating grade crossings is in the hands of the Chancellor of the state who decides whether or not there shall be a grade crossing, and whether it shall be overhead or undergrade.

The Chancellor apportions the costs and expenses of such crossing between the company owning the railroad and the State Highway Department, there being an appeal allowed from the decree of the Chancellor to the State Supreme Court. The law is very flexible and the proportion of cost depends upon the facts in each case.

District of Columbia.—The work of eliminating crossings in the district was covered in acts of Congress in 1901 and 1903 which provided for the elimination of practically all the railroad grade crossings within the city of Washington, which has been carried out.

In this act the district was required to pay the cost of all street changes outside of the railroad right of way and the railroad was required to pay all the cost of the street changes within its right of way.

The legislation also covered a specific plan and its provisions refer to certain streets named therein. It further provided that all or any grade crossings not covered by the plan, their future elimination when authorized should be divided as to cost on the basis of the district paying for all street changes outside the railroad right of way and one-half the cost of all such changes within the railroad right of way, the railroad paying the other half.

Florida. There is no definite law in this state concerning the matter of eliminating railroad crossings.

Illinois.—The matter of eliminating grade crossings is handled by the Utilities Commission and each project is decided by them on its merits. In general, however, the railroad company is required to pay about 70 per cent of the total cost, the balance being divided among the political subdivisions interested, which are usually cities, townships and counties.

The State Supreme Court has held that the Utilities Commission has no power to order grade crossings eliminated and the township or county to pay a portion of the cost, on the grounds that by so doing the Utilities Commission, which is a non-taxing body, would be assessing a tax upon the people.

Kansas.—Authority to order elimination of railroad crossings is vested in the State Highway Commission. When establishing the county road system, the Commission can order crossings eliminated without formal complaint being filed. After road system is adopted a formal complaint must be filed before elimination order can be made. County board files compaint on county roads and township board on township roads.

When crossings are eliminated by relocation, the railroad company must pay from 50 per cent to 75 per cent of the cost of new right of way and such portion of the cost of constructing the new road as the State Highway Commission may direct, the county or township, as the case may be, must stand the balance of the expense. When the crossings are eliminated by a separation of the grades, the apportionment of the cost is left to the decision of the State Highway Commission.

Iowa.—The Iowa law permits the townships or counties and the Commission to co-operate in the matter of distributing the cost of eliminating dangers at railroad grade crossings. There is, in addition, an old law which provides that in case the local officials are unable to agree with the railroad company regarding any particular improvement that they will have the right to appeal to the State Railroad Commission, who is vested with authority to finally distribute the cost of the improvement between the interested parties.

In a number of instances the railroad company has paid the entire cost of the improvement and in one or two cases the county has paid as high as 95 per cent of the cost. As a general rule, when grade crossings are improved, either by separation, relocation or improving the existing crossing, the costs are adjusted on a percentage basis, it being common to adjust such cases on the basis of the county paying 40 per cent and the railroad company paying 60 per cent of the cost of the improvement. Some have been adjusted on the basis of each paying 50 per cent of the cost.

Maine.—Crossing elimination is in the hands of the Public Utilities Commission. The law specifies that the railroad shall pay 65 per cent, the state 25 per cent and the town 10 per cent.

Maryland.—There is a law in this state which permits the State Road Commission to pay a part of the cost, not to exceed 50 per cent, for the elimination of grade crossings and the general custom has been for the Commission to take care of everything off the railroad right of way. In case of a relocation, they condemn the land for the new road and approaches up to the railroad company's right of way.

Massachusetts.—The railroad companies are obliged to pay 65 per cent of the total costs and damages of the alterations and the Commission authorized to apportion the remaining 35 per cent between the Commonwealth and the city or town in which the crossing is situated: provided, that not more than 10 per cent of such cost shall be apportioned to such city or town and that the Commonwealth shall not be required to pay any part of the expense of abolishing grade crossings established after the passage of this act.

It was proposed to amend the law in 1913, but the bill failed to pass.

Michigan.—The proportion of the cost of eliminating railroad grade crossings is determined jointly by the Railroad Commission and the State Highway Commissioner with a limit of 25 per cent of the cost of the project for the state [illegible]

The cases that have been determined have been divided 25 per cent to the state, 37½ per cent to the local community, township or county, and 37½ per cent to the railroad. Projects thus decided have been on trunk line roads. On less important roads the state would pay less than 25 per cent and the remainder of the cost would be divided between the railroad and the local communities.

Minnesota.—Grade Crossings are eliminated by agreement, there being no law fixing any ratio for distribution. In some instances the entire cost of grade crossing elimination is carried by the railroad company. In some instances one-half the cost is paid by the county, while in several other instances the railroad company has built the overhead structure and the road authorities took care of the grading and other work incidental thereto.

Mississippi.—There is no law in this state requiring or permitting the elimination of grade crossings. When such work is done, it is usually paid for by the transportation company and in isolated cases the county or road district has paid portions of the cost by agreement.

Nebraska.—A standard practice in this state has been for the railroad company to take care of the structure and the county to stand the expense of grading.

New Hampshire.—There is no law in this state in regard to the elimination of railroad grade crossings. What work has been performed has been by agreement between the railroads and the town affected.

New Jersey.—The elimination of grade crossings is in the hands of the Public Utilities Commission, which Commission may order the crossings eliminated, by a separation of the grades and by a relocation of the highway. The entire expense of such alteration, changes or relocation, including the damages to adjacent property, shall be paid by the railroad, unless a street railway uses such crossing, in which case the board may order not exceeding 10 per cent of the expense directly chargeable to the crossing used by the street railway company to be paid by the company operating such street railway.

New Mexico.—No legislation covering the subject.

New York.—In the case of new railroads crossing streets, the expense is borne entirely by the railroad company. In the case of new streets across railroads, the railroads pay 50 per cent and the municipal corporation 50 per cent. On state or county highways when the petition for the elimination of the crossing is brought by the Highway Commission, the railroad pays 50 per cent, the municipal corporation 25 per cent and the state 25 per cent. When a highway is constructed across existing railroads and is a part of a state or county highway, the expense of making the crossing above or below grades or changing or rebuilding existing structure, 50 per cent of the cost is borne by the railroad, 50 per cent by the state for a state highway, or for a county highway, 50 per cent by the railroad and the remainder by the state, county and town in the same proportion as for the construction cost of the highway.

Nevada.—Owing to a comparatively light travel and the infrequency of train service, the expense of overhead crossings and subways have been considered inadvisable. In relocating an existing road, it is the policy of the Highway Department to eliminate grade crossings where possible by changing the location of the existing road. As the additional cost of such changes is not great and there is no law requiring the railroads to pay a portion of this cost, the entire amount is borne out of the construction fund.

North Dakota.—The boards of County Commissioners take up the matter with the railroad company and if they are willing to install an overhead crossing, it is done as a voluntary arrangement, the railroad company being required to bear the entire expense of that portion of the improvement which is on its own property. In case the county and railroad company cannot come to an agreement, the county may petition the State Railway Commission, which will then order a hearing and upon facts presented, order a crossing put in, if it is deemed advisable. In either case, the railroad pays the entire cost within the confines of its right of way.

Ohio.—The cost of constructing the improvement authorized, including the making of ways, crossings or viaducts, above or below the railroad tracks, and the raising or lowering of the grades of the railroad tracks and sidetracks for such distance as may be [illegible] provement, together with the cost of [illegible] chased or appropriated, and damage to [illegible] ting property, or other property, shall be borne one-half by the municipality and one-half by such [illegible] companies.

Oklahoma. The state has no authority to compel the railroads to eliminate grade crossings. It has been performed by agreement where the counties pay for the cost of grading and surfacing of such roads and the railroads erect the structures, in which case the railroad companies carry about 90 per cent of the cost.

Oregon.—The matter of railroad crossings is in the hands of the Public Service Commission. Recent [illegible] of the Commission have divided the cost 50 per cent for state and 50 per cent for railroads on trunk lines under contracts by the state, but in some cases where the State Highway Department is doing the work, it has divided the cost 30 per cent for the state 30 per cent for the county and 40 per cent for the railroad.

Pennsylvania.—The Public Service Commission has charge of the elimination. Sometimes the division of cost is made on a 50-50 basis, but more often the Public Service Corporation pays the cost of the structure and the state paves the roadway. The grading of the approaches is very often paid for by the state.

Rhode Island.—This work is handled by the Public Utilities Commission. The matter [illegible] taken up with the railroads by town or city authorities. The Public Utilities Commission decides as to the necessity for the improvement contemplated in case of disagreement. The proportioning of the cost is a matter for agreement between the railroads and the towns or cities, and court action is the last resort in case of disagreement.

Tennessee.—There are no state laws relating to the elimination of grade crossings. The State Highway Department anticipates doing the work in some cases on a 50-50 basis. In all cases the right of way is secured by the county, except that portion of it which is traversed by the right of way of the common carrier.

Texas. The state has no law regarding the removal of railroad grade crossings.

Vermont. Their statute provides that the [illegible] of grade crossings shall be handled by the Public Service Commission and that the township shall pay not more than 10 per cent of the cost and the state not more than 25 per cent, and the railroad the balance.

The Commission usually [illegible] 10 per cent to the town and 25 per cent to the state, and the balance to the railroads as required by the law. In a few extraordinary conditions, a greater portion has been charged against the railroad and the percentage to the town [illegible] reduced. They have an act which requires the railroad companies to spend $75 per mile each year for the elimination of railroad grade crossings.

Wisconsin.—The state law requires that the determination of the necessity for a grade crossing separation and the apportionment of cost shall be made by the Railroad Commission. In some cases the Commission [illegible] mined that the railroad company shall bear the cost of the proportion of the improvement which lies in their right of way. In other cases, they have apportioned the cost on a percentage basis, usually 70 per cent to the railroad company and 30 per cent to the municipality.

West Virginia.—They have no definite law on grade crossing elimination.

Cost of Road Work in Alabama in 1917 and 1918. The cost of road work in the Southern States averaged 50 per cent greater in 1918 than in 1917 [illegible] average costs are from [illegible] cited by Mr. W. S. Keller [illegible] paper presented at the recent meeting of the American Association of State Highway [illegible] increase:

Earth excavation, per [illegible]	[illegible]	[illegible]
[illegible] clay [illegible]	[illegible]	[illegible]
Sand clay surfacing [illegible]	[illegible]	[illegible]
Class A concrete, per [illegible]	[illegible]	[illegible]

Operating Costs of Tractor, Trucks and Sand Screen and Loader in Road Maintenance

In [illegible] county roads in the vicinity of Denver the Colorado Highway Department is employing a tractor, trucks, and a sand elevator, screen and loader. The complete [illegible] of the following: One C. L. Best caterpillar gas tractor of 40-HP. drawbar capacity, weight 28,000 lb., costing $6,000; one grader with scarifier and blade [illegible] and two light drags, 2 White 5-ton trucks and a Kelly-Springfield 5-ton truck, costing $6,000 each; and a Gallion sand elevator; screen and loader, costing $1,500.

Some interesting information on the operation of this [illegible] in a report of the Highway Department by James E. Maloney, Chief Engineer of the Department. The tractor, grader and one drag are generally used together and can be operated by two men. If the work is simply dragging, or smoothing with the grader, a distance of 20 miles might be covered; that is, if one round trip is made they would cover 10 miles of road; if two round trips were necessary, then 5 miles of road would be covered. The latter figure might be taken as an average in all kinds of materials for the dragging.

In many places it is necessary to scarify the surface in order to reshape it and remove the chuckholes and waves. On work of this latter class the tractor and grader are used very successfully, except on macadam or very solid gravel roads, where it is found that the scarifier is too light and it is necessary to use the heavy-toothed scarifier. On scarifying and reshaping it has been found that about ½ mile per day would be an average day's work.

The sum of $50 per day has been taken as the cost of the operation of this particular outfit. This figure is obtained as follows:

Caterpillar tractor, expense per day:		
[illegible]	[illegible]	
[illegible]	[illegible]	
Operator	5.00	
[illegible] year)	8.50	
		—$40.00
Grader and scarifier, expense per day:		
Maintenance	$3.00	
Labor	1.50	
[illegible]	[illegible]	
		[illegible]
Total		$50.00

Some unsatisfactory features should be noted: The tractor [illegible] bridges. It is unwieldy, requiring a cross-road intersection or a full width road for turning. The lighter size tractor of 25 HP. at the drawbar is free from these objections, and will do most of the work that can be done with the larger size.

The two trucks and screening and loading plant have [illegible] and gravel, and the trucks have used the drags occasionally. The use of the trucks on anything but the lighter forms of drags has not been entirely satisfactory, so the Department employed them largely on hauling and spreading materials for repairs of surfacing. The trucks are both of the dumping and spreading type and are working satisfactorily.

[illegible] lowing has been adopted:

Expense for the year	
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
Total	$5,400

[illegible] charge for the sand elevator and loader is based on the [illegible]

[illegible]	[illegible]
[illegible]	[illegible]
Total	$1,500

[illegible] $2 per day, and this [illegible] upon which the work is being [illegible]

Minnesota Engineers and Reconstruction

The December Bulletin of the Affiliated Engineering Societies reprints the editorial from our Nov. 13 issue, entitled "What [illegible] Societies Should Do to Assist in Providing for Soldiers and Others Who Will Soon Be Out of Work." In commenting on the editorial, the editor of the Bulletin points out what Minnesota engineers are doing and can do toward securing public works construction. We quote from the Bulletin as follows:

In keeping with the suggestions outlined in the editorial comes an appeal from our State Highway Commission for assistance in finding a way to avail ourselves of the proper legislation to secure approximately $4,000,000 federal aid for road building in 1919. Minnesota will be able to avail herself of this amount under the provisions of an amendment now pending before Congress provided the State accepts the fund with the assurance that it will appropriate a similar amount for the same purpose. Certain State Constitutional blocks now stand in the way and some way must be found to get around these restrictions.

The engineers of the state of Minnesota are well equipped with society organization with which to shape public opinion as well as to direct in the selection of proper projects to which precedence should be given. In this respect we are fortunately in advance of some of our sister states, therefore no time need be wasted upon organizations through which must come the concentration of our efforts to produce immediate and lasting results.

In the state as a whole the first duty imposed upon the societies, viz., "that of deciding what new public works would be of the greatest value to the public," is a comparatively simple one, for the mind of the engineer as well as of the layman quickly reverts to two projects, good roads and good drainage.

The second duty imposed, that of influencing the public to accept the decision of the engineers and to act promptly upon that decision, is where the real skill and ingenuity are required. In these virtues the engineers as a whole are sadly lacking, and for that reason it is the more urgent that our societies cooperate with other public spirited organizations toward accomplishing this essential feature of the program.

As a beginning toward constructive accomplishments along the lines proposed, the Minnesota joint board has already spent some time in making a study of a reconstruction program and have made certain recommendations to the Affiliated Societies. The St. Paul Society has appointed a committee to recommend definite activities toward reconstruction. The Minnesota State Society committee chairman and officers will take definite action immediately toward recommending necessary legislation tending toward the speeding up of highway and drainage work.

The one point of vital importance for engineers to remember is that continued and constant publicity is required to gain the desired results and in this connection the Bulletin stands ready to publish articles which must be written and published if our efforts are to bring action.

Governor Burnquist has in the past been ready to accept and act upon recommendations from the Affiliated Societies, and being now personally interested in securing more funds for good roads will undoubtedly cooperate if some definite, sane and progressive plan is placed before him.

In the St. Paul Dispatch, page 9, under date of Dec. 3rd, is found a discussion on this subject by our State Highway Commissioner. It behooves us, as progressive engineers, to at once get busy on this all important matter and do our utmost to assist in bringing about this very material aid to our state highways.

Topographical Surveys in Connection with Rural Planning*

By W. H. NORRISH.

We have all been more or less interested in the various proposed modifications of our system of surveys so as to form community or rural villages. I think, though, that most of us have been inclined to smile at the apparent futility of all such schemes which consist merely of a complicated geometrical figure, and do not take into consideration the topography of the ground. I think we are agreed that if there is to be any change, it must be based on topography, and that we do not want another geometrical system, though some of us may feel that these geometrical solutions may help, by giving us suggestions as to methods of planning rural developments. One outstanding point to be noticed in many of the proposed plans of townships is that the lots are triangular in shape and converge on community centers. I fear that the practical farmer will not take kindly to the triangular form.

Soil and Land Surveys for Assessment Purposes.—Californit has recently undertaken soil classification surveys with the primary object of properly assessing the land. The work has consisted of making soil and topographic surveys and maps to show the boundaries of the different types of soils grading them as 1, 2 or 3 of each type, or as unfit for cultivation. All areas in permanent crop such as orchards, vineyards, alfalfa, hops, etc., are shown.

The topography shown consists of streams, dry channels, irrigation or drainage ditches, levees, roads, buildings, fences, brush or timbered areas, etc.

The maps are made by compass and pacing, being plotted in the field or by traverse plane-table. The finished maps on white paper with colored inks show soil acreages, acreages in each permanent crop, acreages in roads, right of way, etc.

These maps are accompanied by a report on the soils showing for what crops they are best adapted, a comparison of values and the irrigation or drainage possibilities.

The type of soil is considered to be the most important consideration in fixing land values. Some of the previous errors in assessment in California were that the same soil at different points the same distance from the railway was assessed much differently, and that all lands of certain districts were assessed at the same rate even though some soils were worth five times as much as others.

All deeds, recorded surveys, or approximate surveys if obtainable, or the original public land surveys, were plotted on the maps before they were sent out.

The scale used was 1 in. to 5 chains and cross-section paper was used for plotting. Other details shown were the variety of orchards or vineyards, and whether good, bad, etc., the annual crops such as hay and grain, the cost of clearing brush on timbered lands, the value of buildings, the size of irrigation or drainage ditches, the condition of roads, levees, etc., and the depth of water in wells. The soils are named in accordance with the soil surveys of the United States Department of Agriculture. Samples of soil for analysis are taken from representative areas and borings are made. Surface alkali is shown by the presence of weeds and under-surface alkali by electrolytic instruments.

The cost of these soil classification surveys in California varied from 3 to 6 ct. per acre, including office costs. It should be borne in mind that on account of the nature of the country such surveys would probably be considerably more expensive than surveys of a like nature in the western provinces of Canada.

What a Topographical Sheet Should Show.—A great wealth of detail can be shown on a scale of 6 in. to a mile.

A very complete set of symbols, such as used by the U. S. Coast and Geodetic Survey, should be devised so as to add to the amount of detail which can readily be shown. In addition to all natural topography and contours I think a topographical sheet should show:

(1) Careful soil notes together with the delineation of the boundary of each class of soil. To aid in soil classifica-

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*From paper presented at the last annual meeting of the Association of Dominion Land Surveyors.

tion, borings should be made and a [illegible] of soil analyzed. The sheet should then be accompanied by a report on the crops which could be successfully grown on each soil, and a climate report. Surface alkali should be shown and underlying alkali detected by electrolytic instruments and shown.

(2) All areas under cultivation and nature of crops. The additional areas fit for cultivation should be clearly traced from the topography and soil notes.

(3) All fences, buildings, roads, railways and other improvements, together with all survey monuments found.

(4) All areas of bush land with notes as to the probable cost of clearing, if such areas are suitable for agriculture. If not suitable for agriculture and if vacant crown lands, data should be shown which would indicate the possible use such areas could be put to, or if they would be better held as forest reserves.

(5) The name of the occupant of each parcel of land and the name of the owner. Where parcels of patented land are found vacant particular care should be taken to obtain full information, including the probable value of the land and improvements.

The latter information would, in my opinion, be very valuable in the hands of the Government. If a way could not be found to force the cultivation of the land, the Government might purchase it and sell it over to an incoming settler, or arrange the purchase for him. The Government would be in a position to give the settler trustworthy information and take the deal out of the hands of unscrupulous real estate agents. The province of Nova Scotia appointed a commission in 1912 to purchase vacant lands, improve them and resell them to bona fide settlers. If a policy such as this could be inaugurated the Dominion Government would regain control of the lands and where necessary to properly plan the development of the district the land might be resubdivided.

I think the time has come when the Government of this country can no longer afford to leave the incoming settler entirely to his own resources and his own discretion in the choosing of land. The best of information should be at his disposal and he should have the help of capable and truthworthy Government officials. It should also be noted that the survey I have suggested would show the exact amount of good land in each parcel, the class of soil and the crops it is suitable for. This would be the very best of information to give the banks in order to secure credit for the prospective settler. Care should be taken that land shown to be worthless by the survey should be held as crown lands, and no chance given to a settler to take it up and waste his time and money trying to farm it.

The uses to which a topographical survey as above outlined could be put would be many and varied. Better roads, drainage and irrigation schemes could be laid out on paper and afterwards surveyed on the ground. The system of subdivision as far as it remains under Government control, or in so far as Government control could be secured, might be modified where necessary to provide for the future development and settlement of the land. If deemed advisable, provision could be made for rural villages or community centers.

Snow Removed at Buffalo with Prison Labor.—Prisoners from the county jail were employed by the city of Buffalo, N. Y., in snow removal work in the winter of 1916-17. The prisoners were placed on the outskirts during the day where streets were drifted, being impassable for fire protection, vehicular traffic and pedestrians. At night they were placed on the down-town streets. They were furnished with warm gloves, caps and rubbers, and in some cases where prisoners did not have warm underwear it was furnished to them. They also were given tobacco every other day, furnished with pipes or cigarette papers, and their lunch and hot coffee were carted to the places where they were working. On the outskirts salamanders were kept going for warming the men and also for keeping the coffee hot. The prisoners were paid 25 cents per day, which was given them upon their discharge. The report of the Bureau of Streets estimates that the city saved over $15,000 through the work done by the prisoners.

English Experience with Road Corrugation*

The introduction of mechanically-propelled vehicles on highways has produced a troublesome and perplexing feature of road wear—namely, corrugation—which, owing to the existing war conditions, when the main roads of this country are heavily trafficked and their maintenance much neglected, has become serious.

The object of this paper is to state the present position of the problem with regard to road construction and vehicle design, and to indicate probable causes of the trouble, with some suggestions for preventing or alleviating it.

The phenomenon of wave formation or corrugation is met with in most cases of rolling motion on a plane surface. As a general rule, the formation of waves on a road surface is accompanied by longitudinal movement of the road material in the direction of the traffic, and this movement usually depends on the tractive resistance of the particular material; consequently, water-bound macadam is more likely to become wavy than tar macadam, and so on.

Horse traffic alone may cause waves to develop, but the damage to a road in this respect is only slight compared with that done by motor traffic. The action of the driving-wheels of motor traffic is similar to the pulling action of horses' hoofs, and causes the upper layers of the road-material to be moved backwards—i. e., in the opposite direction to the traffic; setts, for instance, are tilted backwards. And therefore the combined effect of forward movement as a whole and tilting or backward movement of the surface is to produce ridges and hollows.

The effect of a wheel passing over the hollows of a corrugated surface, or even potholes, is to produce a blow on the opposite side of the hollow, and this is shown to depend upon $\frac{W v l}{r}$ where W, v, l and r are unsprung weight, speed, width of hollow, and radius of wheel.

It is generally admitted that the road roller will form initial waves unless great care is exercised, and that traffic will quickly accentuate them. The Crompton three-axle roller introduces a principle which is of great importance in considering the road wave problem.

The action of a two-axle motor vehicle may be studied by observing the effect when the front wheels meet with an increased resistance due to a ridge or a pothole. The lead of the body of the vehicle on the front axle is increased and the lead of the back axle on the body is likewise increased, owing to the greater resistance to the driving effort; in other words, vibration of the vehicle as a whole is set up by the distance between the front and back axles changing with a definite period, according to the type and suspension of the vehicle. The wheel-base appears to have some definite relation to the period of the waves formed, and a long wheel-base assists the springing of the vehicle, and enables it to hold the road at speed when the surface is rough or wavy.

Considerable improvements in the suspension of the heavier motor vehicles are needed, the present practice only allowing of the absorption of shocks vertically, and not in the direction of the reaction of the blow on the road; in this respect, auxiliary springs, check springs, and shock absorbers are very useful.

The effect of the differential gear in continuing waves along and across a road cannot be too strongly urged, and it is this feature of motor omnibuses which probably accounts for the rapidity with which they propagate waves. If one wheel leaves the road surface, racing takes place, and impulsive driving in both wheels is set up; when the wheel returns to the surface of the road it produces a strong grinding effect on the material. The same action takes place when braking the rear wheels, except that the grinding action is in the direction of motion of the vehicle.

An interesting feature of road corrugation is that it often commences earlier on down gradients and at bends than on [illegible] [illegible] [illegible] [illegible]. In the case of the down [illegible] the reasons for rapid wave-development may be stated as follows:

(a) [illegible] [illegible] speed and vibration.

(b) It [illegible] the [illegible] weight.

(c) Driving action and braking action are greater than on level roads.

(d) The road material is subjected to very great pushing stresses in a downhill direction.

The increased wear at bends is due mainly to the action of centrifugal force bringing greater weight on the outer wheels, and to the differential gear, assisting racing and grinding action. The camber of a road also has some influence on wave formation.

The pitch of the waves is not easily determined from vehicle dimensions, since it often varies at different points on the same road under similar conditions of traffic. The occurrence of rudimentary waves, together with fully developed waves, is another interesting feature of road corrugation. Generally, the pitch is less when the speed is greater; it is also quite independent of the kind of road material laid down.

With regard to the different classes of roads laid at the present time, block-paved roads are only capable of offering resistance to wave-formation when laid on a concrete foundation. Where blocks are laid on a yielding and inelastic foundation, corrugation will be quickly set up and considerable tilting and lateral movement will result from heavy traffic. Moreover, Durax paving and wood blocks do not seem able to resist the destructive forces of modern traffic, and sooner or later waves develop.

It is suggested in this paper that, wherever possible, setts or blocks should be laid arch-shape in plan, to oppose the movement caused by traffic in particular direction, so that the paving may be rendered unyielding both vertically and horizontally.

In the case of macadam and tar-macadam roads the former is quite useless where heavy traffic is concerned, and even tar-macadam offers no real solution to the problem.

The bituminous road-surface appears to be the most suitable for modern traffic, on account of its great strength and also its elastic qualities, which go far to compensate for the unsprung weight of vehicles. Further, traction and vibration are reduced to a minimum. The development of waves on a bituminous surface is analogous to the formation of waves in the rolling of hot armor plate.

It is possible that concrete as a surface, under good conditions, might prove a suitable material, but it has not been sufficiently tried in this country to enable definite conclusions of its wave-resisting qualities to be formed.

The conclusions of the paper show that unless two-axle vehicles can be provided with reasonably good springing, such as results from the air-cushion of the pneumatic tire, some development in the direction of providing three axles, and increasing the number of driving-wheels, accordingly, for heavy vehicles is necessary to alleviate the trouble of road-waves.

Mechanical Hauling Displaces Team Hauling in Michigan Road Work.—In a paper presented at the Chicago meeting of the American Association of Highway Officials, Mr. Frank F. Rogers, State Highway Commissioner of Michigan, stated the mechanical hauling had very largely displaced team hauling in road work in that state. He cited one instance where a motor truck was making five trips with 3-yd. loads of gravel on a haul so long that teams working on the same job made two trips with 2-yd. loads. The truck thus delivered 15 yd. as compared with 4 yd. for each team.

Road School at Purdue University.—The 5th annual road school of the department of civil engineering, Purdue University, La Fayette, Ind., will be held Jan. 7, 8 and 9, in cooperation with the County Road Superintendents' Association, the County Surveyors' Association and the State Highway Association. Prof. R. C. Yeonans, Purdue University, is in charge of the school.

What Is an Engineer?

Elsewhere in this issue we discuss several definitions of the word "engineer," including the one lately put forward by Mr. A. Krom, Director of Engineering of the U. S. Employment Service. The following discussion of Mr. Krom's definition is reprinted from a letter in the Engineering and Mining Journal:

I note with interest a definition, by A. Krom, appearing in the Nov. 16 issue of the Journal, which reads as follows:

"An engineer is one who economically directs manpower, and, by scientific design, utilizes the forces and materials of nature for the benefit of mankind."

A new definition, to be worthy of attention, must be complete. The first point of criticism with that quoted is that it fails to take cognizance of recognized usage. In the United States the operator of a railroad engine or a stationary motive plant is an engineer. The word has been generally accepted in that sense; it is widely used; and no stroke of the pen can summarily displace it. If custom dictates a change, a change will result—but in slow stages. It is illogical to exclude recognized usages in defining the word "engineer." If they are uncommon or secondary, they can be placed in a position which is subordinate to the primary significance.

Mr. Krom's definition appears to me to lack pertinence. Had I seen it by itself, or had I been asked to give a typical example of one who "economically directs man-power, and, by scientific design, utilizes the forces and materials of nature," my mind might have turned to some captain of department-store industry, such as John Wanamaker or Gordon Selfridge. "Science," as Huxley said, "is nothing but trained and organized common sense"; and a scientific mind is an asset in any branch of endeavor.

With regard to the economical direction of man-power, I have encountered many brilliant engineers who were distinctly wasteful of the resources at their command. The history of perhaps the most widely advertised mechanical product of the twentieth century—the Liberty Motor—would seem to indicate that the question of economy was a factor of little or no importance. An engineer who directs man-power economically may be preferable to one who is lavish, but that does not make him any more of an engineer, per se. Again, no human effort could be consummated without enlisting the aid of natural forces and materials. The great inventor from whom a brilliant idea may spring surely utilizes them—his own perceptions and his own brains—just as another engineer uses steel and concrete and available water pressure.

The second part of Mr. Krom's definition appears to be unduly altruistic. A few engineers may carry out their duties with no other thought than the resultant benefit to mankind, but they are indeed few. Others, and they constitute the great majority, work primarily for a salary, wage, or bonus; others, again, in the hope that their investigations and inventions will result in ultimate material profit to themselves.

Practically all honest effort results in a benefit to mankind in general, but little of it is performed with this object in view as the primary consideration. These are plain, blunt facts; but, nevertheless, they state conditions as they are. Much engineering effort is beneficial to mankind, but it would be invidious to emphasize this fact in the formulation of a definition of an engineer. German invention of recent years has shown that the subjugation rather than the benefit of mankind was the main object of many devilish, though none the less brilliant, engineering achievements.

Mr. Krom's definition has served to point out the inadequacy of available information; and the great body of professional men will appreciate the initiative in his effort to standardize nomenclature in this direction. The primary need for such a revision arises from the fact that the engineer's work must be emphasized. There are engineers and engineers. The purely mechanical class will not be deprived of their accustomed appellation by a new definition which ignores their existence. A wider recognition of the fundamental meaning of the word will do much good, and the secondary significance will gradually become obsolete.

Engineering, to my mind, is, primarily, creative effort. An engineer may direct man-power or he may work alone. He may utilize the material forces or products of nature in consummating his ideas, but this is of secondary importance. His difference from his fellow lies not in the economical way he can handle labor, or by the science which he may apply to his work. Neither are his efforts undertaken for the benefit of mankind, any more than those in many other groups of human endeavor. His main characteristic is an ability to bring to his work a creative, inventive spirit of initiative, which marks him as distinct from the technician who merely works under his instructions.

I would suggest a complete definition as follows:

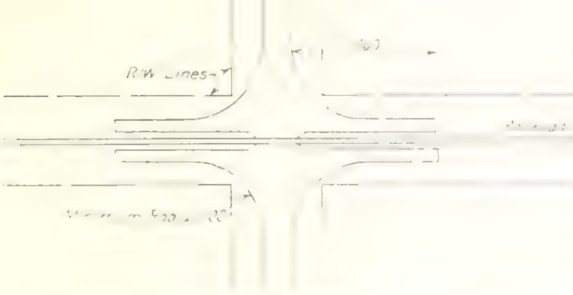
Engineer: 1. A technician who applies creative effort to the solution of a problem, or the operation of an enterprise. 2. One who is skillful, or artful in design. 3. The operator of an engine or other mechanical equipment—an engine driver.

A. W. ALLEN.

New York, Nov. 20, 1918.

Plan for Reducing Traffic Hazards at Railroad Grade Crossings

Relocation of roads and building a short stretch of road at the crossing parallel to the track were suggested by Rodman Wiley, State Commissioner of Public Roads of Kentucky, as precautions at grade crossings. He stated that where a road parallels a railroad for some distance before crossing, the road should, if possible, be at least 300 ft. from the track and the crossing should, if feasible, be made at right angles to the track. In addition, all obstructions to the view should be removed so that when a man makes the turn preparatory to crossing the track he can see both ways up and down the railroad for some distance.



Grade Crossing With Short Safety Roads Paralleling Railroad.

As an added precaution, he suggests that it would be well to build a road parallel to the railroad track for a distance of perhaps 300 ft. each side of the main road, and, in all probability, this should be on the railroad company's right-of-way. The surface of the road should be at the same elevation as the top of the rails. In case a man saw he could not clear the track, or in other words, that he was caught, he could turn, either to the right or left, off the main highway and run his car parallel to the track and prevent a collision.

Of course, such things as electric lights, electric bells, etc., should be used in all cases because they always serve as a good warning.

Important crossings should be well paved, the paving to be level with the top of the rails so as to prevent a man killing his engine on the track; also to save the wear and tear on vehicles.

Less important crossings could be paved with timber, say 2-in. thick, set on edge, sized so as to make it level with the top of the rails, the timber to be nailed to the ties and to each other and all points of contact to be tarred. This would make a rather inexpensive improvement and it is believed the results would be admirable as 2x4s spiked together and tarred have been used very successfully as flooring for bridges in Kentucky.

As a general proposition, it would be well, as has been advocated, to make the road straight and level with the top of the track for a distance of at least 300 ft. each side of the center line of the railroad and to have all obstructions such as brush, high banks, etc., removed so that a man can see both up and down the track when traveling any part of the 600 ft.

Prof. Baker's Statement Regarding His Report on Chicago Pavements

Some months ago Professor Ira O. Baker of the University of Illinois, made a "Report on Pavements" in Chicago which contained criticisms of the engineers and inspectors of the Board of Local Improvements.

These criticisms were challenged and in an investigation made at the direction of the Chicago Civil Service Commission it was admitted by Professor Baker that some of his statements and conclusions were based on premises found to be incorrect.

The Illinois Society of Engineers after a thorough inquiry felt that public acknowledgment should be made of this fact and has obtained from Professor Baker the following letter which is intended for publication and which retracts the original statements reflecting upon the engineers:

To the President of the Illinois Society of Engineers:

Sir: Under date of Nov. 20, 1916, I forwarded to the Committee on Finance of the City of Chicago the manuscript of a report entitled "Report on Pavements Recently Built by the Board of Local Improvements of the City of Chicago." That report [illegible] a considerable shortage in the thickness of all concrete foundations of pavements, and also in the thickness of the binder course and of the wearing coat [illegible] which statements have been [illegible] by the engineers of the Board of Local Improvements.

In preparing that part of my report I [illegible] of the engineers of the technical staff as to whether or not the inspectors selected pavements of particular contractors or pave- [illegible] convinced me that the pavements examined by the inspectors [illegible] all the observations made, and I was informed that they did. I [illegible] report and found them to agree with the summary which the staff had furnished me.

I had no reason for believing that my report was in error in any of these three matters until I heard the testimony of one of the inspectors during the progress of the investigation conducted by a Board appointed by the Chicago Civil Service Commission, March 5-9, 1917. I then learned for the first time that if the inspector found any defects in a pavement, he prepared a somewhat elaborate report from his field notes and filed that report; but if he found no defects, he filed no report thereof. The data furnished to me was a summary of these special reports, and did not include any statement that other pavements had been inspected and found to be according to the specifica- [illegible]

All of my intercourse with the staff engineers convinces me that their only desire was to have the facts correctly presented, and I feel quite sure that they were entirely innocent of wrong intention in the matter.

[illegible] defects found in only some cases, it was wrong to assume that the observations in which defects were discovered were repre- [illegible] ticulars, and am sorry to have made erroneous statements which have been considered as reflecting upon the honor of engineers of the Board of Local Improvements. I intended no such reflection.

[illegible] delayed for a year and a half on account of the fact that three [illegible] concerning the matter by me might be considered as an at- [illegible] not think that the delay in this acknowledgment has done any serious harm, since in the investigation conducted a year and a [illegible] Commission, I freely acknowledged my error, and since the find-

Cost of Obtaining Road Gravel with Sluicing and Washing Outfit

A small portable sluicing and washing outfit, employed by Alex McKay, County Road Engineer of Calhoun County, Mich., for obtaining road gravel, was described by Mr. Frank F. Rogers, State Highway Commissioner of Michigan, in a paper presented at the Chicago meeting of the American Association of State Highway Officials.

The washing plant is now at its fourth location. On the first location an average of 100 cu. yd. of gravel per day was obtained for most of the time, but the later sets have been in more difficult situations. At the third set, work began March 19, 1918, and ended Aug. 31, 1918. The prospect was so poor that the plant was located at that point only after every other prospect had been investigated and over $100 had been spent digging into every hill and running down many reports within a radius of three miles. The pit was cross-sectioned before and after working, thus the figures as to yardage moved are quite accurate. All the gravel was hauled by the yard, so that is another check on the total amount of material secured.

The largest day's run was 44 yd. and the smalllest 15 yd. Men employed were: Foreman at $5, engineer at $3.50, houseman and general helper each $3. About 28 gal. of kerosene were used each day in two engines. A 15-HP. engine ran a 3-in. centrifugal pump giving approximately 250 gal. per minute at about 20 lb. pressure at the nozzle through 500 ft. of 6-in. spiral pipe. A 6-HP. engine was used to run a revolving screen and elevator. A bar "grisley" on top of bins removed oversize stone. Water was secured from a nearby creek. The fine screen was a square mesh of 1/16-in. opening, but there was very little fine sand carried over. Operating data follows:

Days, season, worked 10 hours each	131
Total yardage gravel secured	3,200
Average yardage per day	25
Average daily cost of operation	$19.16
Total cost of operation	$2,511.81
Total yardage moved (bank yd.)	10,500
Average cost per yard in bin	$0.78

After getting all the available gravel in that location the plant was removed to the fourth or its present location, 1½ miles farther from the road. This pit was much more stony and required an additional man to fork stone away from the sluices. This pit had been worked two years before and abandoned on account of the large amount of oversize stone and number of sand packets. For this location the cost was:

Total cost of moving	$162.00
In operation from Sept. 4 to Nov. 15, total number of days worked, 10 hours each	56
Total yardage secured	2,016
Average cost per day	$21.00
Average yardage per day	36
Average cost per yard in bins	$0.59

It will be noted that no depreciation of machinery is figured. The total plant cost is around $2,500. The experience with washing gravel has been that it is possible to work over a large amount of poor material and secure a good road building metal at reasonable cost. The plant, however, cannot compete with good pits located advantageously unless due credit is given for the excellence of the material thus obtained.

Propose Spending $30,000,000 for Road Work in Washington.—A 2,000-mile system of arterial highways in Washington to be financed by bonding motor vehicle license fees is advocated by the Thurston County Good Roads Association. It is estimated that by issuing 20-year bonds on the license fees $30,000,000 could be raised for expenditure during the next 6 years.

Uniform Traffic Laws.—The American Association of State Highway Officials at its convention last month in Chicago passed a resolution that the Association go on record as favoring a uniform traffic law, a uniform regulation of motor trucks and passenger motors, and a uniform law covering the regulation of head lights on motor vehicles.

11,261 Civil Engineering Graduates in 21 Years.—The total number of engineering graduates from 1895 to 1916 was 35,777, according to a circular of the U. S. Bureau of Education. Of this total, 11,621 were civil engineering graduates. The number of students taking engineering courses in 1916 was 33,106.

Steam Shovel on Snow Removal.—During the winter of 1916-17 the Bureau of Streets worked one steam shovel and one steam "skimmer" on snow removal work. These machines, according to the report of the Bureau, were successful and did the work but the cost was not reduced over that of hand labor.

Personals

Martin C. Polk, city engineer of Chico, Cal., has been elected county road engineer of Butte County, California.

Charles J. Peters has been appointed city engineer of Toledo, O., succeeding Lloyd O. Runkle, who resigned recently.

Maj. T. R. Agg, recently of the 98th Engineers, has resumed his work as professor of highway engineering at Iowa State College.

Lt. Col. A. Marston, recently in command of the 97th Engineers, has returned to his duties as dean of engineering at Iowa State College.

N. F. Coffman, Chehalis, Wash., was elected president of the Washington State Good Roads Association at the recent convention at Pasco, Wash.

Maj. Lincoln G. Kelly, formerly state auditor of Utah, has been appointed a member of the Federal Board of Contract Review of the Construction Division. This board passes on contract cancellations and the adjustment of obligations of the various departments.

C. L. Rood, Toledo, O., has been elected president of the Northwestern Ohio Engineering Society, which held its annual meeting at Findlay, O., Dec. 22. The other officers are: Elmer Hilty, Findlay, vice president, and William Scheplin, Wapakoneta, secretary and treasurer.

H. P. Pearsons, of Evanston, Ill., was elected president of the Illinois Municipal League, which held its 5th annual convention at Chicago Dec. 14. The other officers elected are: John E. Hurley, Aurora, first vice president; George H. Crichton, Herrin, second vice president; L. H. Hall, Morris, third vice president; John A. Fairlie, Urbana, secretary-treasurer; Clifford G. Roe, Chicago, general counsel; W. G. Adkins, Chicago, statistician.

Charles Frederick Gray, consulting electrical engineer, has been elected mayor of Winnipeg, Man. Mr. Gray was born in England in 1879 and was educated at Dulwich College, London. From 1902 to 1904 he was on the staff of the Interborough Rapid Transit Co., New York, and for the next two years was engineer for the Metropolitan District Underground R. R., London. From 1906 to 1912 he was construction superintendent for the Canadian Westinghouse Co. He entered private practice at Winnipeg in 1912.

Dr. J. A. L. Waddell, consulting engineer of New York and Kansas City, has been elected a corresponding member of the Academie des Sciences of L'Institute de France. The Academie des Sciences was inaugurated in 1795, and during the succeeding 123 years there have been only 18 corresponding members chosen from the United States, Dr. Waddell making the nineteenth. Of these eighteen three are still living, viz., the astronomers Dr. Edward Charles Pickering of Harvard University and Dr. George Ellery Hale of Washington, D. C., and the geographer, Dr. William Morris Davis, of Cambridge, Mass.

Obituaries

John K. Harris, a contractor of Providence, R. I., died Dec. 17.

William H. Haney, a contractor of Denver, Colo., died Dec. 18, aged 39.

James L. Howell, of the contracting firm of Jas. L. Howell & Son, Nashville, Tenn., died Dec. 18, aged 71.

Industrial Notes

E. A. Williams, Jr., president of The Garford Motor Truck Co., announces a new and very important department for his company. It will be the department of highway development, under the management of S. M. Williams, who has been for the last four years sales manager for the Garford Co. Mr. Williams has for years devoted a great deal of time to the study and investigation of highways throughout the United States and their relation to the motor vehicle industry, and he has constantly urged the necessity of highway development to meet the economic demands of the country in highway transportation. In addition to his duties as sales manager, he has for the last year been president of the Highway Industries Association and has just been re-elected for 1919. In relieving Mr. Williams of the responsibility of sales and placing him in charge of such a department, The Garford Motor Truck Co. realizes that highway development is just starting and as a result of the many uses to which trucks were put as a war necessity the future of the motor truck is doubly assured and that all over the country better highways must be built in order that the motor truck may best serve in the growth and the expansion of the country, which is inevitable.

Waterworks and Hydraulics Monthly Issue

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Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power

Railways and Govt. Works—3rd Wednesday
(a) Excavation and Dredging
(b) Rivers and Canals
(c) Harbors and Docks
(d) Railway Construction

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Ship Construction
(d) Miscellaneous Structures

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E. & C. Index Furnished Only on Request

Hitherto it has been customary to send the index of our articles to every subscriber. In order to conserve paper the index for the six months ending Dec. 31 will be sent only to subscribers who send a postal card or letter requesting a copy of the index. We will then list your name so that you will receive the index twice each year without the necessity of writing us. It will assist us if those desiring the index will notify us at once.

Should Our Government Own the Telephone and Telegraph Systems?

In urging Government ownership of the telephone and telegraph systems, Postmaster General Burleson recently said: "Extension of the wire service should be determined by public needs, not the opportunity for private gain." The implication, of course, is that under Government ownership the "wire systems" would be more greatly extended than they have been under private ownership. If this theory is sound we should find more extensive systems of telephony in England and France where Government ownership exists than in America, whereas the reverse is true. The number of telephones per 100 inhabitants in America is 9.5, as compared with 0.9 in France, 1.5 in the United Kingdom, and 2 in Germany.

Somehow or other the incentive of "private gain" in America has proved to be far more effective in giving people telephone service than has the political ideal of "public need" that has been tried out in Europe.

Director General of Railways McAdoo has said that "an ounce of experience is worth a ton of theory." America has had a bit more than an ounce of experience in telegraphy and telephony. From the day that the American Morse made telegraphy practical, all noteworthy advances in the science of conveying intelligence over electric wires have been made by Americans under the incentive of "private gain" which Mr. Burleson finds so reprehensible that he would do away with it. Europe has done nothing more than follow the lead of our reprehensible Morses, Bells, Pupins, Barretts and Cartys, not to mention the business men who have financed these geniuses. Government ownership of the "wire systems" in Europe has led to nothing but poor imitations of American methods. The "public needs" of Europe have not been effective in giving Europeans as extensive wire service as in America even with the great American models before them. What "wire systems" Europe would have today had it not been for these American models, we leave our readers to imagine.

Mr Burleson has studied neither experience nor human [illegible] diluted sentiment has a fraction of the driving power that exists in a definite, concentrated desire to increase one's personal income. The sentiment that he would invoke is the desire on the part of Government office holders to increase public welfare by extending and improving telegraph and telephone service. Well, that same altruistic sentiment has been at work in Europe a very long time, whereas in America we have seemingly had only the egoistic desire to make money by operating the wire systems. The results of the two methods are before us, and if we doubt our own ability to weigh the results, let us employ a commission of impartial engineers to investigate and report upon the "wire systems" in America and Europe.

Incidentally it may be added that even a money making telephone company is not without its ideals of serving the public where no immediate profit is in sight. At a rate hearing before the Public Service Commission of New York a few years ago, it was shown that the New York Telephone Co. was operating its rural lines and the lines in the small cities at a net return of less than 4 per cent on the capital invested in those lines. The company had deliberately extended its rural lines to give service to the farmers at rates that would not yield even legal interest on the investment. The company considered this to be part of its duty in rendering "state wide" telephone service.

The great president of the American Telephone and Telegraph Co. (Bell system), Theodore N. Vail, has shown as keen an interest in the public and its welfare as if he had been directly employed by the public. He is, we believe, quite as much of an idealist as Mr. Burleson; but he shows a practical idealism in aiming to make the telephone system as a whole yield a fair return on the invested capital. By so doing, his company has been able to finance extensions and improvements at a rate that has been truly amazing, and with corresponding benefit to the public.

In contrast, look at the unprogressive Government owned telephone systems of Europe. In fact, look at our own Government plants in general. Every patent office commissioner for years has begged Congress for larger appropriations, and with uniform lack of success in spite of the fact that the revenues of the patent office greatly exceed the expenditures.

Look at our national highways and contrast their relative poorness with the relative excellence of our railways. The Federal Government has done virtually nothing in all its history to improve our roads, and most state Governments have been almost as negligent. Yet there was as great economic need for road improvement as for railway improvement.

Look at our admirable Reclamation Service, and note the very small size of the appropriations it has thus far been able to secure for irrigating and draining lands, contrasted with the truly enormous acreage that needs either irrigation or drainage.

In fact, turn where you may, you will see legislatures either going to one extreme in pork barrel wastage of public funds for postoffices and the like, or to the other extreme of picayune appropriations for public works of really great economic importance. Certainly this ton of experience weighs more than Mr. Burleson's ounce of theory.

Common Errors in Estimating the Cost of the War

The true cost of a war to a nation is not the sum total of its expenditures for the war, nor is it that total plus the capitalized decrease in gross earning power of its citizens. In fact we have never seen even an approximately correct statement of the true cost of any war to any nation.

Because Great Britain has expended 40 billion dollars in prosecuting the great war, it does not follow that that sum represents the true net cost of the war to that part of society known as Great Britain. A simple illustration will show the absurdity of any such estimate. When the war started, Great Britain's wealth (exclusive of her provinces and India) was about 85 billion dollars. Suppose Germany were now to pay Great Britain the 40 billion dollars that she has expended. Great Britain would then have approximately 125 billions of wealth, less the net decrease in her shipping values. Probably some deduction should also be made for other antebellum property destroyed during the war. An inventory would show about 120 billions of property at the end of five years, instead of the 85 billions at the beginning of the war. In short, by merely "recouping her war losses," Great Britain would find herself nearly 50 per cent wealthier than when the war began!

Clearly something is wrong with the reasoning that leads to such a result. The error arises, in part, from failure to deduct the normal cost of living from the cost of the war. It has been said that more than half of all the workers in Great Britain were engaged either directly or indirectly in the war. If there had been no war these workers would have had to live, and they would have expended practically all their earnings to support themselves and their dependents. The war served to change the character of their work, in most cases, but it did not change their living expenses save to increase them. Hence it follows that if these men are paid for their five years' war work by Great Britain, and if Great Britain then collects their entire war wages from Germany, these workers will have eaten all their cake and yet will still have most of it; for what belongs to Great Britain belongs to all her people.

How is the true cost of a war to a given part of society like Great Britain, to be determined? Without going into some of the minor, yet important elements of the problem, we will outline the major elements and the general method of procedure in solving it.

When an individual is deprived of property by condemnation for public use, the law provides that he shall be paid in money a sum that will give him as good an income after the loss of the property as he would have enjoyed had it remained in his possession. Applying this "rule of reason" to a nation that is to be recouped for war losses, it would follow that the nation should at least be left as wealthy after the war as it would have been had there been no war. If, then, the nation had been increasing its wealth at the rate of, say, 5 per cent a year (after making proper allowance for changes in prices); and if the war had lasted 5 years, then the 5 per cent compounded for 5 years would be more than 25 per cent of the pre-war wealth. From this should be deducted the nation's actual increase in wealth during the war, at pre-war prices. The remainder would be the loss in wealth as a result of the war, provided none of the pre-war property were destroyed by the war. Any pre-war property destroyed by the war would be, of course, a war damage.

In brief, an appraisal of national wealth just prior to the war should be deducted from an appraisal made after full resumption of normal peace activities, using pre-war prices in both cases; then the difference between these two appraisals should be deducted from the normal increment in national wealth that would have occurred during that period, and the remainder would be the loss in national wealth incident to the war.

To this loss in wealth should be added the total value of the lives destroyed and lost earning capacity of the maimed and injured. And finally there should be added a heavy penalty as a punishment. The total would be the war indemnity.

Before the war the wealth of the leading nations was estimated to be as follows:

United States	$190,000,000,000
Great Britain and Ireland	85,000,000,000
British possessions, including India	45,000,000,000
France	50,000,000,000
Russia	40,000,000,000
Italy	20,000,000,000
Belgium	9,000,000,000
Germany	80,000,000,000
Austria-Hungary	25,000,000,000

The war expenditures of all nations are said to have totaled nearly 200 billions of dollars. The indemnity claims of the Allies, it is estimated, will exceed 120 billions, or 20 per cent more than the pre-war wealth of Germany and Austria-Hungary combined. Lloyd George has announced that in equity, Germany should be made to pay the entire war expenses of the Allies plus damages to property. Property damages in France and Belgium are estimated variously at 5 to 25 billions of dollars.

It is apparent that great diversity of opinion will exist as to what the indemnity to be paid by the defeated enemy should be. On the theory that it should include the entire war expenses of the allied nations, the total would be far different from that arrived at by the appraisal method above suggested.

It seems to us that the finding of the true cost of the war to each of the allied nations is primarily a problem of engineering economics. It certainly is not a mere matter of bookkeeping. Yet even in accounting it is erroneous to consider only the debit side of a ledger without due regard to the credit side. A national ledger—in distinction from a nation's ledger—has yet to be posted to show the net loss to any nation as a result of a war.

How the "War Gardens" Can Be Made Profitable Peace Gardens

It has been announced by the National War Gardens Commission that 5,285,000 "war gardens" in America last year yielded vegetables whose market value was $525,000,000 or about $100 per garden. Most of these gardens were at least partly irrigated with water from city water works. Probably it is not an over-estimate to say that even this partial irrigation increased the total crop by 20 per cent. If so city water works systems should be credited with having added about one hundred million dollars to the national income in 1918.

In round numbers the total investment in American city water supply systems is about two billion dollars. Since $100,000,000 is 5 per cent of this investment, and since the increased tonnage of coal used for pumping for garden irrigation was relatively small, it seems probable that the increased yield of war gardens as a result of irrigation alone amounted to about 5 per cent on the entire investment in water works systems.

Whether the foregoing figures are correct or not, they are sufficiently close to the truth to make clear the great economic possibilities of using city water for garden irrigation.

For many years Engineering and Contracting has been urging the irrigation of city and suburban gardens. We have shown repeatedly that vegetable crops can be doubled even in the humid states by irrigation, and that the profits from garden irrigation alone would pay a handsome dividend on the entire investment in water works plants. It has been objected that while this might be true, it would be impracticable to get many people to raise gardens in cities. The war has answered this objection by leading nearly six million city families to raise vegetables.

There are fewer than twelve million families living in municipalities. The existence of more than five million war gardens last year proves that nearly half the city families were easily persuaded to go into truck gardening. Since the average garden yielded $100 worth of vegetables, it is evident that war gardening was not only worth while as a food production measure but that it was so profitable as to warrant its continuance.

No water works superintendent should hesitate hereafter to use his best efforts to promote garden irrigation. If existing pumps, reservoirs and pipes are too small, now is the time to urge city councils to appropriate money for additions and improvements. Let experienced hydraulic engineers be given the problem of providing more water where more water is needed. Also let these engineers establish schedules of water rates that will encourage irrigation while at the same time providing an annual net return of, say, 5 per cent on the total investment in the plant.

In order to encourage the greater use of water for garden irrigation, all consumers should be metered, and a low rate per 1,000 gal. put into effect for all water in excess of the amount needed for other domestic purposes. In short, the precedent established so successfully by electric companies should be followed, namely, the giving of a very low "wholesale rate." In many cities electric companies charge one-tenth as much per kilowatt hour for current used in large quantities for power as they charge for small quantities of current used for domestic lighting. In this way electric companies have built up a very large, profitable "power load."

Nearly all water departments of cities and water companies have always regarded water as a commodity that needed no advertising. But behold what the general advertising of war gardens has done in the brief space of two years! It has educated five million city families to raise vegetables where not one-tenth that number were formerly interested in vegetable gardening. Incidentally, the majority of them have had to use water to pull their crops through dry spells. Suppose they had all been encouraged to use water judiciously. Suppose pamphlets had gone out with every water user's bill, telling what the U. S. Department of Agriculture has discovered about the increased yield of irrigated gardens. In short, suppose city water had been regarded as a commodity to be advertised, can any one now doubt the effect of such publicity?

Water works superintendents, city engineers and civil engineers in general, an enormous, undeveloped field lies before you—the field of garden irrigation. Not only every vacant lot but nearly every back yard can be converted into a profitable garden, and its yield increased enormously by irrigation with city water. It is well within possibility thus to raise two billion dollars worth of vegetables each year in our municipalities and their immediate suburbs.

Public Utility Rates

To the Editor: In your issue of Dec. 11, Mr. John J. Moore, "owner and manager of Water Works Companies, Boston, Mass.," makes an argument favoring increase of water rentals and cites a number of cases where public utility commissioners have determined a fair rate of interest on the fair valuation of the property to be from 6 per cent to 8 per cent over and above operation and depreciation.

The war conditions have certainly had more effect than simply to raise wages; they have caused public utility commission also to raise rates of interest to what I consider absurd figures. Government, state and municipal bonds, even in these war times, seldom bring more than 5 per cent. Ten million dollars worth of 4½ per cent Denver Water Co. bonds were offered at 95 and were oversubscribed, $2,000,000 within 24 hours, and in less than a week were being sold at 97½, and this in the face of the last liberty loan drive.

Money which is secure in its interest is not worth nor will it bring more than 5 per cent even in war times when offered in any considerable amount. Assuming, however, that 5 per cent return is the value of money in peace times, why make the return on water plants 6, 7 or 8 per cent? The returns are practically guaranteed by the intervention, control and decision of the public utility commissions. If the interest return is guaranteed it should be no higher than that of good first class bonds of the municipality covered by the utility.

But, you say, this is war times. To be sure it is, and we are all called upon to bear our proper burdens; no man should profiteer. As a whole we all lose money and are poorer at the end of the war than at the beginning. Why not the owners of a water plant also? Why increase the normal loss of the consumer by trying to maintain to its full measure the dividends of a water plant? This wartime cost raising is no mere merry-go-round because it spirals always upward; raise the price of labor, raise the price of raw materials, raise the returns of public and other utilities, raise rates of interest, and then start all over again. This would not be an unjust procedure if "labor" included all men, but it has a very restricted meaning today, with the result that half of the people and half of the business is left on the ground while the H. C. L. climbs a pole for the benefit of the other half. But the war will soon be over and then it will take a brick to bring prices down. (See cartoon in Saturday Evening Post of Dec. 21.)

The point I make is, in short, this, whenever the public assumes to guarantee through its public utility commissions a reasonable return on the investments that very guarantee eliminates practically all risk of the investment and gives the utility a monopoly, and the interest return should not be more than the interest rate on bonds of the municipality itself. Also the assessed value for the purpose of taxation should be the same as the valuation for rate making purposes.

Unless the public utilities commissions prove to be true and honest mediators between the owner and consumer, [illegible] or they decide [illegible] presented" the utility presents voluminous evidence and data, the consumer almost never presents any whatsoever—these commissions will be a failure. The result will be some effort on the part of the consumers to devise some new method of control; probably the commissions will be made elective and become the football of the agitator, reformer and Bolsheviki politician, with the result that the utilities will be dealt with unjustly and unreasonably, and their geese [illegible] and many will die.

Now that the war is over, let us sit steady in the boat for a while and see "where we are at" and "where we go from here."

[illegible] JOHN E. FIELD.

Absurdity of One Stock Argument Against Metering

As an argument against the installation of meters it is frequently claimed in the public press that the extravagant use of water serves to flush out the sewers and thus improves the sanitary condition of the community. The absurdity of this argument is well pointed out as follows by Mr. Edward E. Wall, Water Commissioner of St. Louis, Mo., in his annual report for the year ending April 1, 1918:

The flow necessary to accomplish any flushing of consequence would require a depth of at least 4 in. in the sewers with a velocity of 2 ft per second. All house drains in St. Louis connected to lateral sewers 12 in. or more in diameter. The quantity of water necessary to produce the above flow in each of these 12-in. sewers would approximate 300,000 gal. per day, which would have to be supplied at the upper end of each lateral sewer. There are usually less than 50 houses connected to the upper 800 ft. of these sewers. Assuming that [illegible] houses are inhabited by 250 persons, the daily per capita use of water to provide the 300,000 gal. necessary for adequate flushing would be 1,200 gal., which is almost nine times the actual average daily per capita for the year 1917-18. That is to say, all of the pumps in the water works, operated at full speed, could furnish but little more than one-ninth of the water necessary to flush the sewer system to a very limited extent. In all probability the actual normal dry weather flow in each of these sewers does not exceed 20,000 gal. per day. A continuous rainfall of 0.1 in. per hour over the area drained by the upper 800 ft. of these lateral sewers would be equivalent in quantity to the flow above specified necessary for flushing the sewers. An ordinary rainfall of ½ in. or ¾ in. in an hour would do more good in flushing out sewers than all the water pumped by the water works in a week, even if it all could be discharged into the sewers of St. Louis within two hours.

Government Forms Bureau to Revive Public Works Construction.—A new bureau—the division of public works and construction development—has been established by the U. S. Department of Labor. The activities of the bureau will be devoted to pressing the construction of public works and private building enterprises to provide jobs for the jobless during the critical period of reconstruction. According to figures in possession of the department of labor $3,000,000,000 worth of public and private building construction have been postponed because of the war. It will be the purpose of the new bureau to press immediate renewal of work on these enterprises. Franklin T. Miller, President of the Dodge Reports Co., is director of the Bureau.

The city of Los Angeles, Cal., contemplates an expenditure of $600,000 for supplying aqueduct water to the Westage annexed district.

"An Economic Crime to Burn Coal for Mere Heating"

By HALBERT P. GILLETTE

Charles P. Steinmetz, Consulting Engineer of the General Electric Co., recently said:

"It is an economic crime to burn coal for mere heating without first taking out as much high-grade energy, mechanical or electrical, as is economically feasible. It is this feature, of using the available high-grade energy of the coal, before using it for heating, which makes the isolated electric station successful, though it has every other feature against it."

Engineers know, but few other men do, that in generating power from coal only about 12 per cent of the chemical or thermal energy of the coal it utilized. The rest of the energy is lost unless it is used for heating purposes.

In round numbers America uses annually about 200 million tons of coal for heating and 200 million tons for generatig power If, however, all the coal used for heating were also used so as to generate power at a thermal efficiency of 10 per cent, it would require only 240 million tons to do all the heating and furnish all the power of 400 million tons now used. In other words, 40 per cent of the 400 million tons could be saved annually.

Mr. Steinmetz says:

"It is obvious that we never could completely accomplish this; but even if we recover only one-quarter, or even only one-tenth of this waste, it would be a vast increase in our national efficiency."

While it is true that it is impracticable to secure a 40 per cent saving in fuel in this manner, there are other savings that can readily be accomplished which would result in a total saving of fully 40 per cent. For example, the average household furnace has a heating efficiency of only 50 per cent, due partly to poor design, partly to failure to insulate the furnace and pipes, and partly to poor methods of firing the furnace. This efficiency can be raised from 50 to 65 and even to 75 per cent.

About half the heat "radiated" from a building is "radiated" through the windows. Double windows would almost cut this loss in two.

One of the greatest engineering problems of the future will be the problem of conserving the rapidily diminishing supply of fuel. As nearly as can now be predicted, the solution of this great problem will be along the following lines:

1. Coal will be entirely separated from the slate that now forms such a considerable percentage of the "commercial coal." This will probably be accomplished by floating the coal on an agitated mixture of stone dust and water, the specific gravity of this mixture being greater than that of the coal and less than that of the slate. By eliminating the slate entirely the thermal efficiency of the fuel will be increased about 10 per cent.

2. The coal will be ground to powder, mixed with water and pumped from the mines to the central markets. There it will be dried and burned.

3. The powdered coal will be burned in central power plants, being fed by compressed air into furnaces, or it will be exploded in the cylinders of "gas engines." About 20 to 25 per cent of the thermal energy of the coal will thus be converted into power.

4. The heat not utilized in generating power will then be used to heat buildings, being carried in steam or water through heat insulated pipes. A very high efficiency of insulation will be secured by lagging the pipes with granular or fibrous material in air-tight casings filled with dry carbonic acid gas having half the conductive power of the nitrogen and oxygen which constitute nearly all the air.

5. Every building will be so designed as to reduce heat losses to an economic minimum. All windows will have double panes, hermetically sealed and filled with carbonic acid gas. The walls and roofs of buildings will be properly insulated. See my article on Heat Transfer in Engineering and Contracting.

As engineers know, it is idle to talk of heating buildings with electricity generated by steam power [illegible] only 25 per cent of the thermal energy of the coal can be converted into electric power, at best, it will involve a loss of more than three-fourths of the heating power of the fuel to heat buildings by electricity.

Central steam heating plants already exist in a good many cities. The detailed costs given in Chapter 19 of the Handbook of Mechanical and Electrical Cost Data, by Gillette and Dana, make it very clear that steam heating of buildings from a central station is now economically effected. That the economy can be greatly increased there is no doubt. The heat lost in transmission through a well designed system of underground steam pipes is only 5 per cent as a rule, and need never exceed 10 per cent. But the investment in the piping system is rather larger larger than it need be if a better heat insulator than wood be used. I have already indicated what I believe should be done to increase the efficiency and reduce the first cost of the heat insulator.

In order to reduce the size of the underground steam pipes it may ultimately become the practice to use steam under higher pressure than is now common, thus following the precedent furnished by many gas companies.

The problem of heating buildings with exhaust steam from a central station is fascinating in the extreme, for it presents enormous possibilities of effecting economies hitherto unattained; nor are these possibilities merely speculative. Our knowledge of the laws of thermal conductivity and radiation is much greater today than it was even a few years ago. The successful use of powdered coal has already demonstrated our ability to make every grain of coal do effective work. The recently discovered fact that coal can be floated on an agitated mixture of sand and water points the way to a method of perfectly separating coal from slate.

Although some of the above given suggestions for fuel conservation may sound visionary, there is not one of them that does not rest upon actual test.

Methods and Costs of Thawing Water Mains and Services

Data on the 1917-18 experiences of 96 cities with frozen water mains and services are included in the report of a special committee of the New England Water Works Association. The methods employed by these cities in thawing are summarized in the following table:

	[illegible]	[illegible]
Electricity	[illegible]	[illegible]
Steam	[illegible]	[illegible]
Hot water	[illegible]	[illegible]
[illegible] hot water	[illegible]	[illegible]
Electricity [illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

One city reported that the blow torch was employed in thawing services; another city employed fire.

The cost of thawing with electricity per job varied from $20 to $1. A summary of the costs is as follows:

No. of cities	Reported cost	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	5	Less than $3

The cost of thawing with steam ranged from $4.50 to $75, the later figure being reported by Stamford, Conn. One city reported a cost of $5, one a cost of $17.70, one $20, one $9.41, one $7.63, one $4.50, one $7.50, one $6.50, one $16.50, and one $14.

The reported cost of thawing with hot water ranged from $2 to $20. Four cities reported the cost as being $2. One a cost of $2.67; three a cost of $3; five a cost of $4 to $5; three a cost of $5 to $6; one a cost of $11.20; one $14, one $17 and one $20. One city reported the cost as being 5 ct. per foot of pipe thawed.

Three cities reported on the cost of thawing by fire. In one case the cost was $11.16, in another $10.69 and in the third $10 to $30.

Actual Quantities of Water Used on Irrigation Projects of U. S. Reclamation Service

[illegible] on the experience of the U. S. Reclamation Service in the use of water on its several irrigation projects are given by Mr. E. A. Moritz, Engineer of the Service, in the Reclamation Record, from which the matter following [illegible]

The data have a bearing only on the reclamation of arid lands by irrigation. They give information on the quantities of water used in the past, which will obviously be a large factor in determining the quantity to be used as a basis in the study of further development.

It is well known that possible irrigation development is limited, not by the area of the arid land, but by the quantity of water available. A reduction in the quantity of water used on any area will therefore result in a corresponding increase in the area that can be supplied with water and raise crops. The determination of the correct quantity of water to be figured on in planning and building an irrigation system is therefore a large and important problem—and a very difficult one.

To a very large extent, past experience must govern in the solution of this problem. What has this experience been and how can it be made use of? The general results obtained by the Reclamation Service on its several projects are shown in Table I. To make intelligent use of this information requires that it be carefully analyzed in the light of local conditions and requirements and a careful consideration of all controlling or modifying factors.

This discussion deals only with quantities of water delivered to the land and does not include seepage and other losses from the carriage system and reservoirs, knowledge of which is of equal importance in determining the total quantity of water required for a given area of land.

The original Reclamation Act was passed in 1902 and construction of irrigation projects thereunder was begun within a year or two thereafter. In the 16 years that have passed since the act became operative, irrigation works have been built to supply water to 1,600,000 acres of land, of which over 1,000,000 acres are now being irrigated. The projects are scattered throughout all the states west of the 100th meridian and vary in area from 10,000 to 200,000 acres. They probably embrace all temperature, precipitation, and soil conditions that exist in the arid regions and taken together represent a composite picture of reclamation by irrigation in the United States.

For this reason, the results obtained by the Reclamation Service in the use of water for irrigation are of general value and applicability throughout the arid regions of the West. The results are of special interest and value because the operations on all these projects have been standardized to the greatest practical extent and the results are therefore more susceptible of direct comparison than if they had been obtained under conditions of divergent methods of record keeping, operation, and general management.

Data on use of water have been accumulating on some of the projects for 10 years or more, but the operations were not sufficiently standardized on all the projects till about 1912—and some were not in operation before that year—so that a sufficient degree of confidence could be imposed in the comparative data collected before that time. The data herein are therefore limited to the years 1912 to 1917.

In 1914 the Reclamation Extension Act was passed by Congress, which included a provision that operation and maintenance charges to be paid by the water user should be based on the quantity of water used. To carry this provision into effect, it became necessary to measure the water to each individual, or in some cases to groups of individuals who used the supply in rotation, and this required considerable modification and extension of the water measuring system in some cases. The results of water measurement may therefore be considered as more accurate for the years 1915, 1916 and 1917 than for the years 1912, 1913 and 1914, because during the latter three years some approximations or estimates had to be made to round out the data.

The information contained in the table was compiled from the annual operation and maintenance reports of the several projects. Each of these reports is a careful and elaborate compilation of the results of the year's operation prepared by those in direct charge of the work under the supervision of the project manager. Printed forms with detailed instructions for their use are used both for collecting and reporting the information, which makes it all directly comparable as far as methods are concerned.

The great majority of water measurements are made over sharp-edged Cipolletti weirs, but in many cases this method of measurement is impracticable due to lack of the necessary drop in water surface or because of silt accumulations, and as substitutes submerged orifices are mostly used.

The climatological data are taken with standard Weather Bureau outfits, and the means and totals are reported for each month. The weather stations are generally located at the project headquarters and on some of the large projects there are no doubt variations in remote parts of the project from the climatic conditions as determined at the weather station. These variations are, however, insufficient to vitiate the general applicability of the measured data to the whole project. The annual report gives the means and totals for each month of the year.

At the close of each irrigation season a crop census is taken by the ditch riders and water masters. The area in each kind of crop is estimated by visual inspection. No instrumental surveys are made, as the estimates can be made sufficiently accurate without, and any errors made in individual cases are probably balanced in the total.

Columns 3 to 8 of the table give the depth, in feet, of water delivered to the land. Each figure given is obtained by dividing the total quantity delivered to the land for the whole project by the total area irrigated. The figure given is therefore the average depth of water applied to each acre of the total area that was irrigated. Column 9 gives the arithmetical means of the figures in columns 3 to 8.

Column 10 gives the total precipitation, in feet, during the irrigation months. Column 11 gives the sum of the figures in columns 9 and 10 and represents the total depth of water applied by irrigation and rainfall during the irrigation months.

The precipitation during the winter and spring, before irrigation commences, is an important factor influencing the quantity of water required during the succeeding season, especially during the earlier months thereof, and the purpose of the figures in column 12 is to give some idea of the extent of this influence. The mean temperature and wind movement during the irrigation season also affects the water requirements. These are given in columns 13 and 14. Data on wind movement are available for only about half the projects.

Another important factor affecting the water requirements is the character of the crops grown. The percentages of areas in different types of crops are given in columns 15 to 19. The figures are weighted averages for the six years of record and are therefore not applicable to any

TABLE I—WATER USE ON PROJECTS OF THE UNITED STATES RECLAMATION SERVICE

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
		Depth of water delivered to land (feet).												Percentage of area in different crops.					
State.	Project.	1912	1913	1914	1915	1916	1917	Mean.	Rainfall during irrigation season (feet).	Mean plus rainfall during season (feet).	Mean annual precipitation (feet).	Mean temperature during irrigation season.	Average monthly wind movement (miles).	Grain and seed.	Hay and forage.	Fruit and nuts.	Vegetables and truck.	Miscellaneous.[1]	Character of soils on the irrigable area.
Arizona	Salt River	[illegible]	2.9	2.4	[illegible]	2.8	[illegible]	2.59	0.65	3.54	0.68	69	3,602	18	67	2	3	10	Sandy loam with clay in places.
Arizona-California.	Yuma	[illegible]	4.4	3.7	3.3	3.2	3.7	3.81	.22	4.03	.22	74	4,214	35	46	..	2	17	Rich alluvium.
California	Orland	4.0	3.0	4.1	3.4	4.1	3.5	3.67	.35	4.02	1.57	70	.....	8	87	[illegible]	2	..	Sandy and gravelly loam, silt loam.
Colorado	Uncompahgre	[illegible]	5.1	5.1	5.6	6.1	6.0	5.43	.60	6.03	.86	60	4,486	32	43	6	14	5	Red sandy gravel, adobe, clay loam.
Idaho	Boise	1.9	2.4	2.6	2.8	3.6	3.1	2.72	.61	3.33	1.19	61	3,857	48	47	2	3	..	Clayey loam, light sandy loam, sandy loam.
Do	Minidoka	4.3	5.0	4.3	3.9	3.7	[3]2.4	3.34	.55	3.89	1.04	59	...	32	55	..	6	7	Sandy loam, clayey loam, valcanic ash.
Montana	Huntley	1.5	1.5	1.4	1.0	1.1	1.1	1.28	.74	2.02	1.16	63	2,700	35	38	..	2	25	Ranges from heavy clay to light sandy loam.
Do	Milk River	[illegible]	.9	.8	.7	.7	1.0	.82	.71	1.53	1.15	56	.....	38	61	..	1	..	Sandy loam, clayey loam, and some gumbo.
Do	Sun River	[illegible]	1.5	1.7	1.1	1.2	1.4	1.44	77	2.21	1.06	59	.....	46	51	..	3	..	Sandy loam, clay, adobe, and alluvium.
Montana-North Dakota.	Lower Yellowstone.	[illegible]	1.3	1.6	1.4	1.2	1.8	1.43	85	2.28	1.24	62	....	54	43	..	2	1	Deep sandy loam predominates; some alkali and gumbo.
Nebraska-Wyoming.	North Platte	[illegible]	2.5	2.9	1.4	[illegible]	2.1	2.22	.91	3.13	1.26	[illegible]	5,428	35	51	..	4	10	Sandy loam.
Nevada	Truckee-Carson.	[illegible]	2.3	3.3	2.9	3.3	3.1	2.90	.24	3.14	.42	59	2,936	10	86	..	2	2	Sandy loam, sand, adobe, clay, and volcanic ash.
New Mexico	Carlsbad	[illegible]	2.3	2.4	2.1	2.4	2.3	2.42	1.08	3.50	1.24	66	....	26	55	1	1	17	Pecos sandy loam with large lime content.
New Mexico-Texas.	Rio Grande[4]	5.4	[illegible]	5.7	5.9	6.7	8.4	6.07	.65	6.72	.82	67	7,695	24	62	2	4	8	Rich alluvium.
Oregon	Umatilla	[illegible]	[illegible]	[illegible]	[illegible]	5.0	6.2	6.87	.74	7.61	[illegible]	[illegible]	6,093	[illegible]	[illegible]	[illegible]	[illegible]	2	Sandy loam.
Oregon-California.	Klamath	1.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.11	[illegible]	[illegible]	1.11	[illegible]	...	[illegible]	[illegible]	..	2	1	Disintegrated basalt, volcanic ash and diatomaceous earth, being largely classified as Yakima sand loam.
South Dakota.	Belle Fourche.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.2	[illegible]	.83	1.89	[illegible]	[illegible]	[illegible]	50	47	..	1	2	Heavy clay soil sandy loam.
Washington	Okanogan	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.13	.41	2.54	[illegible]	62	....	6	[illegible]	70	7	..	Volcanic ash, sand, and gravel.
Do	Sunnyside	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.62	61	....	[illegible]	[illegible]	[illegible]	9	3	Volcanic ash, sandy loam.
Do	Tieton	[illegible]	[illegible]	2.1	1.8	2.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	64	..	[illegible]	44	12	19	2	Volcanic ash.
Wyoming	Shoshone	[illegible]	2.4	2.1	[illegible]	2.3	2.1	2.11	16	2.57	[illegible]	56	....	[illegible]	[illegible]	..	2	2	Light sandy and clay loams.

[1] On the Salt River, Yuma and Carlsbad projects this item is principally cotton and cotton seed and on the Huntley and North Platte projects it is principally sugar beets.

[2] Does not include water used in November and December, which is small. Irrigation is practiced on the Salt River project throughout the year.

[3] Pumping unit only, embracing about one-half the total irrigated area of the project.

[4] On the Rio Grande project water has been furnished by the Reclamation Service to numerous community ditches and records of the quantity of water applied to the land are not available.

[5] Water shortage.

one year, but should be considered in connection with the mean water application given in column 9.

The last important factor, the character of soils on the irrigable area, is given in column 20. This information is very general. The descriptions of soil are approximately as stated in the annual reports of the Reclamation Service to the Secretary of the Interior. There is, of course, a large variety of soils on every project, but certain types predominate and fix the quantity of water needed as far as this factor controls. The predominating soils only are therefore mentioned.

The map shows the geographical location of the several projects.

In interpreting the significance of the figures in columns 3 to 9, several other factors not indicated in the table should be taken into consideration. These may be stated as follows:

(a) The figures do not, in most cases, represent the quantity needed to successfully raise crops, but the quantity used. This is because generally there was an abundant supply available and there was no great incentive for exercising rigid economy.

(b) In most cases, there was a considerable area of new land brought under irrigation each succeeding year, which required much larger quantities of water than land that has been under irrigation for several years. This, of course, raises the average quantity used and required on the whole area.

(c) The methods and practices of irrigating often have not been highly efficient.

The information given in the table is intensely practical. It shows results that have been obtained in the use of water during a period of six years by an organization which made every effort to get satisfactory results and keep accurate records thereof. The information should therefore be of considerable value for predicting future conditions.

Ohio Storage Reservoir Act Constitutional.—The U. S. Supreme Court in a decision handed down Dec. 31, declares constitutional the Ohio act providing for the construction of storage reservoirs for flood prevention purposes. The opinion was given in proceedings, brought officially, to test the legality of $25,000,000 in expenditures made for conservancy purposes in the Miami River Valley district, but it also affects similar expenditures made under the act in other parts of the state. The act was attacked on the ground that it would levy a tax upon residents of other states owning property in Ohio, and that the money would not be used for drainage purposes, but for the erection of artificial interferences with drainage.

An expenditure of $1,235,000 is contemplated by the Benham Falls Irrigation Co., of Eugene, Ore. The company proposes to irrigate 83,300 acres of land. The supply will be from the McKenzie River.

Results of Cleaning Water Mains at St. Louis

As a result of cleaning the water mains the carrying capacity in certain sections of the distribution system of St. Louis has been greatly increased. Up to April 1, 1918, 153,900 lin. ft., of 6 in. to 20 in. mains of a 50 mile contract had been cleaned. In handling the work prompt house to house inspections were made before and after cleaning and as a result consumers were inconvenienced but slightly from choked service connections. The incrustations removed in the cleaning process were composed of lime, salt and mud mixed with an iron deposit which adheres firmly to the sides of the pipe. In addition to this natural incrustation, rocks, sticks and various other articles were removed during the cleaning process. In the report of Edward E. Wall, Water Commissioner, for the year ending April 1, last, tables are given showing the progress of the cleaning and the results obtained. One table shows that from 151,511 lin. ft. of mains, 7,182 cu. ft. of dry incrustation was removed. The total weight of this incrustation was 246.12 tons. The weight of the incrustation per lineal foot of pipe cleaned ranged from 0.42 lb. to 28 lb. This latter deposit was found in a 736 ft. section of 20 in. pipe in Broadway. A deposit of 9 lb. per lineal foot was removed from a 5,270-ft. section of 20 in. main in Tower Grove Ave. The average weight of 1 cu. ft. of dry incrustation was 68.5 lb.; the average weight of 1 cu. ft. of wet incrustation was 84.7 lb. The following table, reprinted from Mr. Wall's report, shows the increased carrying capacity obtained as the result of cleaning.

While Machine is Moving Through Main. Just as Machine is Ejected from Main. As Water is Clearing Up. Clear Water Coming Through Clean Main.

Various Stages of Cleaning of 20-in. Water Pipe at St. Louis, Mo.

[illegible]

The National Water Main Cleaning Co., New York City, is [illegible]

Drainage Work Advertised in South.—Drainage districts in Southern states are now calling for bids on ditch work requiring several million yards of excavation. The Middle River District of Franklin County, Georgia, opens bids Jan. 15 on 1,000,000 cu. yd. of work; The Turkey Creek District of York, S. C., also opens bids Jan. 15 on 861,000 cu. yd. of

Operating Features of the Chain of Rocks Filter Plant

[illegible] of water were [illegible] The amount [illegible] washing filters, dissolving aluminum sulphate, etc. This cost, states Mr. [illegible] Filter Plant, in his last annual report, includes the cost of operation, maintenance, [illegible] used in the applied and filtered water.

The 40 filters were continually in service except for short periods when minor repairs were being made. The rate of filtration during the year varied from a maximum of 143.1 million gallons per acre per day to a minimum of 31.1, averaging 85.2 million gallons per acre per day. The maximum run of a filter was 206.75 hours filtering 22.63 million gallons, the minimum run was 7.67 hours filtering 1.24 million gallons and the average run was 50.23 hours filtering 5.66 million gallons.

During the year 8,964 filters were washed, using 614.38 million gallons of water or 1.57 per cent of the water filtered.

In December, 1916, and again in December, 1917, the depth of the sand beds in each filter were measured. Ten of the 40 filters showed an average depth increase of ¼ in. of sand, three of them showed no change in depth and the remaining 27 filters showed a loss of ¾ in. of sand.

The rate of wash during the year has been kept fairly constant, being about 15 gal. per square foot per minute. With this rate of wash the mud balls do not accumulate, but with a lower rate the increase in number and size is quite noticeable. Once every month each filter is washed at a rate of 17 gal. per square foot. At this time a ¼-in. screen is pulled through one section in each half of the filter unit. The number of mud balls caught on the screen are counted; if there is an increase over the previous month the rate of wash is increased until the mud balls are again normal. In this way a good check is kept on the condition of the sand bed.

A considerable amount of sand was found on top of the strainer plates, varying from ¼ in. to 1 in. in depth; some of the lateral channels were completely filled with sand. The depth of sand under the plates varied from 3 in. at the east and west ends of the filter to nothing toward the center.

Part of the effluent pipe was removed and an examination of the interior of the under-drains were made. Sand was found in the 10 in. pipe connecting the outlet castings in the filter bottom. Concrete and rubbish were found in the four 10 in. elbows in the under-drain system which reduced the area from 30 to 50 per cent. This material was removed by drilling 1½ in. holes in the under-drains and loosening the material with a chisel and flushing with a hose.

Two cracked center plates and about twelve broken U-bolts were found and some of the end plates were not properly grouted, particularly the end of the plate near the wall, leaving sufficient room for sand to get by. A large number of holes in all of the plates were found stopped up with sand and underneath all of the plates there was a soft greenish scale forming, which is now about 1/32 in. thick in places. This scale reduced the area of a large number of holes. An analysis of the scale gave the following results:

[illegible]	10.6 per cent
[illegible]	[illegible] per cent
[illegible]	[illegible] per cent
[illegible]	41.0 per cent
[illegible]	[illegible] per cent
[illegible]	Trace
Pb SO_4	2.2 per cent

All of the sand in the lateral channels was flushed to the central channel with a hose and removed with scoops. The center plates were replaced and the end plates grouted where necessary. After cleaning all of the holes in the plates and replacing the gravel and sand, the filter was put in operation. The loss of head in washing was reduced from 16 ft. to 7.8 ft. by the overhauling.

On July 2[illegible]th it was found that a stick could be shoved through the filtering material to a bare strainer plate in the north half of Filter No. 2 while washing. On examination it was found that several end strainer plates were loose, which had caused the gravel in three places to be washed out in heaps. The loose plates were fastened and regrouted.

On Feb. 11th, 1918, after draining down Filter No. 25, preparatory to washing, a large hole was observed in the sand bed on the north half of the filter. Upon exposing the strainer plates it was found that one U-bolt had broken in an end plate, causing the plate to be slightly bent up. This break probably occurred on the previous wash. Several cubic feet of sand were found in some of the latteral channels at and near the break as well as some sand in the underdrain pipe. This sand was removed as in Filter No. 23. Debris, concrete, etc., was likewise removed from several elbows.

U-bolts are probably broken by admitting the wash water too rapidly at the beginning of the wash. Every U-bolt that has thus far broken was found to be a defective one, half of the section showing an old break. The break always occurs at the bottom of the U. In going over our stock of U-bolts it was found that about 25 per cent could be broken very easily by merely pulling apart with the hands.

The total amount of air entrained during a single run of each of eight filters was measured once during each month from July to January. The measurements were made as follows: The filter was drained preparatory to washing to within a few inches of the top of the sand. The effluent valve was shut and quick measurements taken to compute the apparent amount of water required to fill the filter to the overflow of the lateral gutters. Wash water was then very slowly admitted until the water was about to overflow in the gutters. During this interval all of the entrained air was liberated. The actual amount of water admitted was measured in the wash water tank. The difference between the actual amount and the computed gave the volume of entrained air at less than atmospheric pressure. The water temperature was taken at each measurement. The average for 8 filters was as follows: At 0.8°C. temperature of water, 6.87 cu. ft. of air per M. G. of water filtered per hour; at 7.6°C., 2.90 cu. ft.; at 12.4°C., 1.06 cu. ft.; at 21.5°C., .89 cu. ft.; at 26.4°C., 51 cu. ft.

In October and November, 1917, a test was made on each of the 40 filters to determine the accuracy of the rate controllers while filtering at various rates. The results show that the average indicated rate is about 1½ per cent higher than the actual rate.

During the year 1922.48 tons of aluminum sulphate have been used. The average cost of unloading is $0.203 per ton.

The aluminum sulphate is added to the water in solution form, the strength of solution depending on the charge. The charge has varied during the year from a minimum of 0.11 grains per gallon to a maximum of 3.68 grains per gallon, the average being 0.6634 grains per gallon of water filtered. The solution strength has varied from 1 per cent to 3 per cent. The solution is kept as weak as possible to prevent unnecessary corrosion of the metal parts with which it comes in contact.

The concrete dissolving boxes were thoroughly overhauled during the year. The concrete surface was chipped, resurfaced with sand and cement, painted with a heavy coat of pitch and then two coats of asphalt paint were applied. The outlet piping from the dissolving boxes and all elbows and tees placed horizontally have been renewed.

The waterproofing on the bottom of the solution tanks has been worn off, but on the side walls it is still intact. The exposed concrete surface at the bottom is in fair shape, only the finish being raveled.

The agitator shafts in the chemical solution tanks are constantly exposed to the action of the sulphate solution. A new shaft was put in No. 3 tank last June, and it is probable that those in the remaining tanks will need replacing during the coming year.

All of the 3 in. gate valves (twelve in number) around the chemical solution pumps leaked badly. They were repaired by casting new gates and scraping the seat in the body of the old valve. The repairs were made in September and no trouble has been experienced since.

All of the 3 in. bronze piping around the chemical pumps has been taken apart during the year and the interior scraped and painted with asphalt. The scale in the pipe was very hard and about ⅛ in. thick. Aside from this scale the interior of the pipe is in very good condition, the hard scale protecting the metal from corrosion.

In November a new set of impellers and labyrinth rings were put in each of the two chemical pumps, the old parts being corroded to such an extent that it was becoming impossible to pump enough solution to supply the demand.

The sulphate solution is pumped through two 4 in. lead lines to a receiving trough at the north end of the filter plant. The excess is returned to the pumps through a single 4 in. lead line. The west discharge line is connected up by 1¼ in. lead pipe to the influent pipe at each filter. Several times during the year these pipes have had to be cleaned of the deposit that settles out from the sulphate solution.

The greater part of the soft deposit is flushed out, but there is a rather hard scale that forms in the pipe that must be scraped out with a disc. An analysis of the hard scale follows:

Loss on ignition	SO_3	[illegible] per cent
	H_2O	1.[illegible] per cent
SiO_2		6.4 per cent
Fe_2O_3		[illegible] per cent
Al_2O_3		6.1 per cent
PbO		[illegible] per cent
Ca and Mg		trace

Except for a period of 20 days during the month of February the equivalent of 14 lb. of sulphate in solution form was added to each filter after washing.

The bronze outlet casting in the orifice boxes of the automatic chemical meters and the conical plugs that regulate the area of the outlet, have been corroded by the sulphate solution to such an extent that the automatic control does not properly change the amount of solution to be fed in proportion to the amount of water passing the 8 ft. meters. Regulation must frequently be made by hand. These parts will be replaced in a short time.

Dissolved Oxygen as Index of Pollution

Ever since the appointment of the Harbor Pollution Commission of New York City in 1903, a systematic attempt has been made to keep track of the pollution of the harbor water. The Metropolitan Sewerage Commission, Dr. Geo. A. Soper, president, recognized the value of dissolved oxygen determinations as a measure of the digestive capacity of the water and, inversely, of its pollution, and tests begun by the Commission in 1909 have been continued by the Board of Estimate and Apportionment of the city, of which Nelson P. Lewis is Chief Engineer, to the present time. The results of these tests are very significant and show a surprising and persistent decline in the degree of saturation in all parts of the harbor, especially in the Harlem and lower East Rivers. As is recognized by sanitary engineers conversant with the situation, this is a matter of considerable importance to the welfare of this great seaport, and especially to those living or owning property in the vicinity of its shores. In a paper presented last month at the Chicago convention of the American Public Health Association, Mr. Kenneth Allen, Engineer of Sewage Disposal of the Board of Estimate and Apportionment, shows to what extent the pollution of the main parts of the harbor has progressed, as manifested by determinations of dissolved oxygen.

In all 2,342 samples were analyzed by the Metropolitan Sewerage Commission and 1,859 by the Board of Estimate and Apportionment. In the interpretation of results a distinction must be made between those tests made in cold weather and those made in summer. While there is a progressive decrease in the warm weather saturations, the winter figures remain high throughout. Even as late as April this holds good, as will be seen from the following:

In April of this year, the percentage saturation found in the Hudson River varied from 70.8 per cent to 73.3 per cent; in the Harlem River from 69.8 per cent to 79.0 per cent; in the Lower East River, from 76.0 per cent to 79.3 per cent, in the Upper Bay, from 62.0 per cent to 77.0 per cent, and in the Kill Van Kull, from 65.5 per cent to 68.0 per cent.

The lowest average percentage of saturation is seen to be 62 per cent, while others range up to 79 per cent; a condition of the water that in this regard may be called entirely satisfactory.

The general conclusion to be drawn from this is that there is no danger of the development of putrefactive conditions with their attendant odors in any of the main bodies of water in New York Harbor during the cold months of the year. And, as a corollary, it follows that for an indefinite time no steps to prevent such putrefactive conditions during cold weather will be necessary. In fact, the saturation figures are so high that even fish life, which in general may be said to require about 50 per cent dissolved oxygen, is not likely to be seriously affected. This refers to the water of the main channels only.

The significant determinations are therefore those made during the warm months, and for our purposes those confined to the months of June, July, August and September only have been compiled, the averages at certain stations being as follows:

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
The Narrows	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Upper Bay, Robbins Reef	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hudson River	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Harlem River	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Upper East River	[illegible]	[illegible]	[illegible]	50	..	..	47
Lower East River	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

The latter show graphically the general increase of pollution in the harbor. Stated roughly, it may be said that in the Harlem River and the East River there is but half as much dissolved oxygen in summer as there was in 1909, and in the rest of the harbor but about three-fourths as much as in that year. The increase in population during this period directly tributary to the harbor (omitting New Jersey), which is the chief contributing factor in the depletion of oxygen, is shown below:

[illegible] New York [illegible] certain branches of the harbor:

	[illegible]	[illegible]	Increase [illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible] Lower	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

Now, while odors may occur with the discharge of large volumes of septic sewage or by the generation of gas bubbles by fermentation of the underlying sludge, they are not produced in polluted water until the dissolved oxygen is entirely used up. The change is then rapid to the putrefactive stage with its repulsive odors. The importance of avoiding this condition is evident, and it follows that minimum saturations are of prime significance. These, for several points in the harbor, are given below:

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	62	[illegible]	43	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	64	[illegible]	[illegible]	70	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	49	[illegible]	25	[illegible]	25	29	25
155th St.	55	57	[illegible]	[illegible]	[illegible]	22	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	64	[illegible]	[illegible]	[illegible]
Morris Heights	[illegible]	29	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	19	[illegible]	[illegible]	28 19	[illegible]	[illegible]	19

As the worst conditions naturally occur near sewer outlets and at other points near the shore where currents are retarded and where deposits of sludge have formed, we may infer from these figures that:

(a) The conditions in the Lower East River and the Harlem River are such that local nuisances from foul odors may be looked for at any time after several days of very hot weather.

(b) The conditions in certain parts of the Hudson River and of the Upper East River are approaching those that already obtain in the Lower East River.

Rates and Duration of Flow in Service Pipes*

BY CALEB MILLS SAVILLE,
Manager and Chief Engineer, Water Department, Hartford, Conn.

Very little information seems to be available in regard to rates of flow in service pipes and their duration and no device was found on the market for getting an autographic record of the continuous use of water through service pipes and meters. Having had some experience with the Friez automatic rainfall register, the writer suggested to one of his assistants the possibility of adapting the recording mechanism of this machine to the required purpose. After some experimentation, Mr. J. E. Garratt, Office Engineer of the department, made suitable electric connections between the meter-counter and a rain gage recorder, and carried out in an able manner the field work of investigation. The apparatus is rather clumsy to take about, but it answers the purpose very well and from its record some very interesting facts have been learned regarding use and waste of water. The apparatus is carried in a box 18x18x20 in., and including box weighs about 4 lb. The instrument is crude and probably not extremely accurate, nevertheless the records are submitted at this time as an indication that may throw some light on the matter of water unaccounted for in systems where the services are very thoroughly metered. At any rate the subject of meter accuracy of registration at low flows and the loss of head on high ones seems to be well worth careful study in the interests of economy, efficiency and conservation.

Apparatus for Recording Flow in Service Pipes.

The registering apparatus consists of an 8-day clock with driving mechanism for rotating a cylinder about 4 in. in diameter around which the chart is wrapped in one fold. A very ingenious device carrying the recording pen is operated by electric contact at each tip of the bucket in the rain gage or each revolution of a counter in the case of a meter. The driving mechanism is so constructed that the drum makes an entire revolution every six hours and the feed is so regulated that the pen describes a spiral on the rotating chart, the lines of which are about ¼ in. apart, and thus avoid being superimposed. Rate of flow is indicated by the number of contacts registered by the pen on a chart. Each of these contact marks is in the form of a step, the characteristic trace being five steps down and five steps up. From top to top of any series of steps there are 10 contacts. The chart is marked vertically in five minute lines. At a glance, therefore, it is possible to read the number of steps or revolutions in any given period and also observe the time at which the water was drawn. One defect in the registering device is its inability to record sudden flows of less than 1 cu. ft., although the total quantity is registered.

For an example of the use of the recorder, on the No. 576 Farmington Avenue chart (Fig. 1) the record began about 10:40 a. m., Tuesday, June 12, and the preparations for lunch are clearly shown. At 11:47 a draft of about 2.5 cu. ft. per minute; at 12 noon another draft of a similar amount. Throughout the afternoon there was some use up to about 3 p. m., then a period of comparative rest until about 6 p. m., when for 2 hours during the dinner period there was intermittent use. At about 10:25 a use of about 5 cu. ft. in four minutes indicates possibly the filling of a bath tub. From this time until 6:17 the next morning there was no flow, indicating either remarkably tight plumbing or a meter which failed to register small flows. From 7:10 to 8:50 a considerable use of water is noted, used probably for bathing and for the family breakfast. The maximum use in the house on this day was 1.25 cu. ft. per minute, and it is noted that the recording mechanism checked the meter reading of 68 cu. ft. for the 24 hours' use. For the week that this house was under observation the following consumption and maximum rates were shown:

	Consumption Cu. ft.	Consumption Gals. per cap.	Max. rate per min. cu. ft.	Duration of max rate min.
Thursday, June 5 ...	65	81	1.00	3.0
Friday, June 6 ...	24	30	1.65	2.0
Saturday, June 7 ...	46	58	1.33	1.5
Sunday, June 8 ...	34	42	*	*
Monday, June 9 ...	52	61	2.20	2.0
Tuesday, June 10 ...	43	53	1.30	2.5
Wednesday, June 11 .	68	85	1.00	2.0
Thursday, June 12 ...	68	85	1.25	4.0

*Pen out of order.

In Table I, made up from the chart record of the same house June 5 and 6, many interesting features appear which seem to be characteristic of this class of service. The rates of flow of this house, and also from an apartment house for a 24-hour run, made up from the autographic records, are shown in Fig. 1. From this study it appears that probably in the first house (upper chart of Fig. 1) at least 11 per cent of the water delivered was unrecorded by the meter, while for the entire 24 hours, except for 3 minutes at about 10.43 a. m., the rate of draft was below 2 gallons per minute. The upper chart (Fig. 1) shows these

TABLE I. RECORD FROM ¾-IN. MOTER ON NO. 576 FARMINGTON AVENUE, JUNE 5 AND 6, 1916.

1 Time.	2 Elapsed time, min.	3 Observed quantity. Cu. ft.	4 Observed quantity. Gal.	5 Rate, G. P. M.	6 Duration of flow, per cent of 24 hr.	7 Probable accuracy of measurement based on meter mfgs. schedule.	8 Probable actual delivery of water gallons.
10:50-11:10	20	2	15	0.75	1.40	0.91	16.5
12 n.	50	7	52.5	1.05	3.5	.93	56.5
1:40 ...	100	3	22.5	.23	6.9	.80	28.1
3:15 ...	95	4	30	.32	6.6	.85	35.3
3:45 ...	30	6	45	1.50	2.1	.96	46.8
4:35 ...	50	5	37.5	.75	3.5	.91	41.3
6:45 ...	130	5	37.5	.29	9.0	.80	47.0
9:25	160	2	15.0	.10	11.1	.60	25.0
10:20 ...	55	2	15.0	.27	3.8	.80	18.7
10:50 ...	30	6	45.0	1.50	2.1	.95	47.3
7:00 ...	490	0	0.0	.00	34.0	...	....
8:00	60	3	22.5	.38	4.2	.85	26.5
8:20	20	3	22.5	1.13	1.4	.94	23.9
9:15 ...	55	9	67.5	1.22	3.8	.94	71.8
10:40	85	6	45.0	.53	5.9	.90	50.0
10:43	3	4	30.0	10.00	.2	1.00	30.0
10:50	7	1	7.5	1.07	.5	.93	8.1
	1.440	68	510.0	.36	100.0	0.89	572.8

6 persons ....86 gal. per capita
Recorded amount ....510.0 gal. in 24 hr.
Probable amount ....572.8 gal. in 24 hr.

Unrecorded ....62.8 gal. in 24 hr.
11 per cent not recorded

Column 7 of the table was obtained by straight line proportion between the low rate giving 98 per cent and the rate giving 90 per cent for the given sized meters based on the schedule of the Meter Exchange. From present information available it appears that the percentage of registration between the given limits varies as a curve instead of a straight line and the actual condition is less than that used here.

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*From a paper presented at the December meeting of the New England Water Works Association.

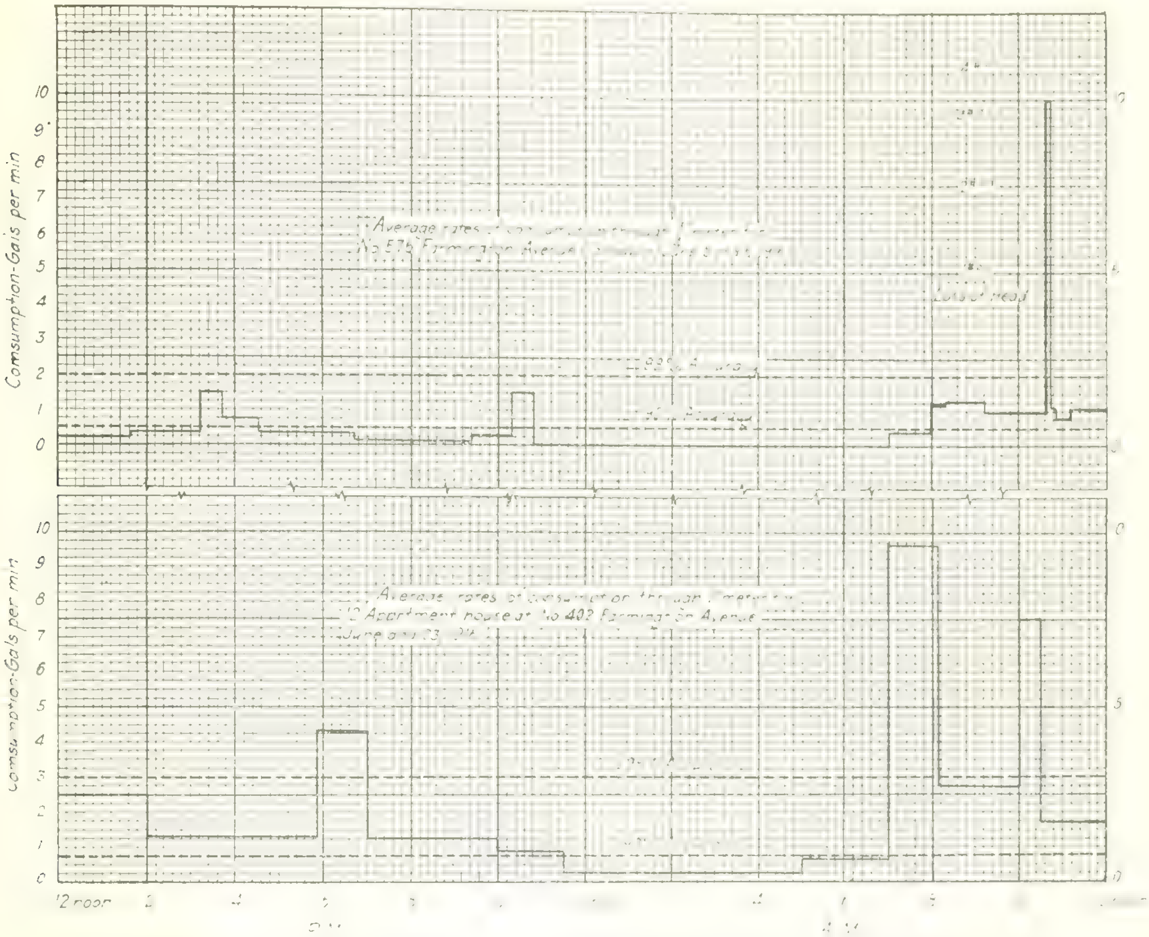

Fig. 1—Average Rates of Consumption in 1-Family Dwelling and in 12-Suite Apartment House.

rates graphically for the single dwelling, while the lower chart shows the rates for the apartment house mentioned below. The most interesting matter in relation to both of these diagrams is perhaps a condition which is clearly brought out, namely, that for most of the time the flow through the meter lies in the zone between the 90 per cent and 98 per cent accuracy ordinarily guaranteed from disc meters. If this condition is characteristic of meter performance it at least offers an explanation for accounting for some of the hitherto unaccounted for water reported from fully metered water departments, ordinary rates appearing to occur on that portion of the scale where the registration is the least accurate in the meters used.

The house under consideration is a one-family dwelling in the best residential part of Hartford, built perhaps 12 or 15 years ago. It is generally occupied by six persons and in the year 1916 had a total use of 16,400 cu. ft., equivalent to an average per capita consumption of [illegible] gals. per day. The water pressure here is about 70 lb. The premises were originally served through a ⅝ in. meter. A complaint was made of inadequate service and a new 1 in. service pipe had been installed by the owner. A request for a 1 in. meter was made on advice of the plumber, a ¾ in. meter was attached and the owner was rather put out at first because the larger sized meter was not installed. The water fixtures in this house comprised: Three set tubs in laundry with hot and cold water, 1 sink in laundry with hot and cold water, 1 sink in kitchen with hot and cold water, 2 water closets, tank type, 4 wash stands with hot and cold water, 1 bath tub with hot and cold water, 2 ¾ in. hose bibs in [illegible].

In investigating this house the following report was made: "With two cold water faucets open in the basement laundry and one hose connection in the garage only a fair flow of water was obtained in the bath room faucets on the second floor. With this demand the ⅝ in. meter showed a rate of 2.25 cu. ft. per minute, which is in excess of the 'maximum proper rate of flow.' A ¾ in. meter is recommended." This installation has been perfectly satisfactory.

In one of the highest class apartment houses recently built, containing 12 separate suites and having an average population of 40, the use of water in 1916 was at a rate of 72 gals. per capita. The static pressure in the street main is about 70 lb. per sq. in. There is a 1 in. meter on the premises which is giving satisfaction.

This house was fitted with the most modern plumbing throughout and has a garage attached.

Table II shows average rates from noon on Wednesday, June 22, 1916, together with computations indicating conditions which exist relative to recorded use of water:

According to this record, there was comparatively accurate registration of the amount of water supplied for less than 7 hours. During the remainder of the 24 hours the registered amount of water seems to have been at least from 8 per cent to 10 per cent less than that actually de-

TABLE II

1	2	3	4	5	6	7	8
		Observed quantity.					
Time.	Elapsed time, min.	Cu. ft.	Gal.	[illegible]	[illegible] of flow, [illegible]	[illegible]	[illegible]
12 n.-2 p. m.	120	40*	299			.97*	
2:00-5:50	230	40	[illegible]	1.3		.92	
5:50-7:00	70	40*	299				
7:00-10:00	180	30	[illegible]		12.5		
10:00-11:30	90	10	[illegible]				
11:30-5 a. m.	330	10	[illegible]	0.23			
5:00-7:00	120	10	75	0.62			
7:00-8:10	70	90*	[illegible]		4.9		
8:10-10:00	110	40*	299		7.5		
10:00-11:30	30	30*	234		2.1		
10:30-noon	90	20	150		6.3	.93	21.5
	1,440	360	[illegible]	1.87		.963	

*Assumed as accurate.
†Estimated accuracy.

[illegible] only a very small [illegible] per cent [illegible] the amount delivered in [illegible] discrepancy of about [illegible] is the service [illegible] $6.13 [illegible] in the department.

[illegible] paid on many services supplying small families on which ⅝-in. meters are installed at a present cost of $15. There seems to be no logical reason why it is not as desirable to receive pay for the water passing through the service whether it be a large or small consumer. If a more accurate measuring device than those in present use will necessitate paying a higher price than the present type of meter costs, water departments can well afford to pay the additional cost if they can be assured of more accurate results than seem possible with the present meter.

The records of the use of water in both the private house and the apartments are representative of conditions in a large number of houses in Hartford and elsewhere. Probably the demand in these houses is much larger than in many others, yet even in these examples it appears that the maximum rates observed are only just within the limits of the 4 per cent accuracy, which is the best the meter manufacturers are willing to guarantee. The bulk of the use of water in a private house of the class here noted is apparently at a rate of from 0.5 to 1.0 gal. per minute. The accuracy of registration for this rate on the basis of the meter manufacturers' schedule for this size meter is probably about 92 per cent, that is, on such service in ordinary use about 8 per cent of the water used is not accounted for. A ⅝-in. meter would account for a much greater proportion of the water drawn. On the other hand, its use would be totally unsatisfactory to the consumer, because it would cut down the pressure when large quantities of water were required and so interfere with the efficient operation of the plumbing.

All that has been said regarding the accuracy of registration of water for the private house applies with equal force to the apartment house. In this case with the 1 in. meter a rate of flow of ¾-gal. per minute only is guaranteed for registration within 90 per cent accuracy and flows of from 1 to 1.5 gals. per minute would probably be recorded within from 92 to 95 per cent of the true amount. An inspection of the chart for this service indicates that for at least during 18 out of the 24 hours the demand for water was less than 1.5 gals. per minutes and at rates which from 90 to 95 per cent only was recorded for payment to the department.

Temperature Variations in Concrete of a Retaining Wall

In the reconstruction of the Compton Hill reservoir in St. Louis, Mo., a concrete retaining wall was built, enclosing the basins. This wall being subjected to large variations in temperature, it was determined to make some investigations to determine the temperature changes in the concrete during and subsequent to setting. For this purpose three resistance bulbs for an electrical thermometer were set in the concrete as it was placed. The results of the investigation are summarized by Mr. F. R. Wiederholdt, Assistant Engineer, in the last annual report of the Water Commissioner of St. Louis.

The wall is 10 ft. high, 18 in. thick and extends around the basins on top of the earth embankment. In the east wall three thermometers were placed; No. 1 3 in. from the east face; No. 2 in the center, and No. 3 3 in. from the west face of the wall. All three thermometers were in the same vertical plane and 4 ft. below the top of the wall. A fourth thermometer was placed close to the wall by the other thermometers.

All the temperature readings in the concrete were taken with a Leeds & Northrup electrical resistance thermometer; the temperatures of the air were taken with a mercury thermometer.

At the time of placing the concrete the air temperature was 50° F. and the temperature of the concrete was 61° F. During the first 21 hours readings were taken every hour, after which readings were taken at 3-hour intervals for a period of several days. In the 13 hours immediately following the placing of the concrete the temperature gradually rose to 68¼° F., while during the same period the air temperature fell to 31° F. In the next 24 hours the air temperature varied from 31° F. to 57° F., while the temperature of the concrete gradually fell to 64½° F. The thermometers nearer the face of the wall, i. e., Nos. 1 and 3, were more affected by the outside temperatures than No. 2 in the center of the wall.

About 120 hours after the placing of the concrete the temperatures of the air and concrete followed each other more closely, although the changes in the temperature of the concrete were somewhat slower than the variations in the air temperature.

Readings were taken at various intervals extending over a period of 11 months, readings being obtained for temperatures ranging from —16° F. to 106° F. As these extreme temperatures lasted for only a comparatively short period of time, the difference between the corresponding concrete temperatures was somewhat less, namely,—10° F. and 100° F., respectively, or a total variation of 110° F. in the concrete wall.

In Table I are shown the readings taken during the first 19 hours after placing of the concrete, and in Table II are shown the readings taken at various times under the extremes of temperature.

TABLE I—TEMPERATURES OF CONCRETE AND AIR DURING FIRST 19 HOURS AFTER PLACING CONCRETE.

Date.	Time.	Temperature Readings No. 4 Outside.	No. 1 East Face.	No. 2 Center.	No. 3 West Face.
Feb. 21, 1917	3:00 p. m.	58°	59	58½	58½°
Feb. 21, 1917	3:15 p. m.	57°	59½	62	61°
Feb. 21, 1917......	4:15 p. m.	51°	59°	63°	61°
Feb. 21, 1917......	5:15 p. m.	48°	59½°	63°	61°
Feb. 21, 1917	6:15 p. m.	44	59½	63	61°
Feb. 21, 1917	9:15 p. m.	38	59½	63¼	60¾
Feb. 21, 1917......	10:15 p. m.	38°	59½°	63¼°	60¾°
Feb. 22, 1917......	12:15 a. m.	37°	59½°	63½°	61°
Feb. 22, 1917......	1:15 a. m.	35°	59¾°	64½°	61½°
Feb. 22, 1917	2:15 a. m.	[illegible]	60¾	67¼	63¼
Feb. 22, 1917......	3.15 a. m.	33°	62°	68¼°	64¾°
Feb. 22, 1917	[illegible] a. m.	31	63	68¼	65
Feb. 22, 1917......	6:15 a. m.	30°	63½°	68°	65°
Feb. 22, 1917......	8:15 a. m.	38°	63¼°	67°	65°
Feb. 22, 1917......	9:15 a. m.	42°	63¼°	66½°	64¼°
Feb. 22, 1917......	10:15 a. m.	42°	63¼°	66°	63¼°
Feb. 22, 1917......	11:15 a. m.	43°	63°	66°	63¾°
Feb. 22, 1917......	12:15 p. m.	46°	63°	66°	63¾°
Feb. 22, 1917......	6:15 p. m.	52°	63½°	65°	63¾°
Feb. 22, 1917......	9:15 p. m.	49°	63¼°	65°	64°
Feb. 23, 1917......	12:15 a. m.	52°	63¼°	64½°	63½°
Feb. 23, 1917......	3.15 a. m.	57°	63½°	64½°	63½°
Feb. 23, 1917......	9:15 a. m.	52°	64°	64½°	64½°
Feb. 23, 1917......	12:15 p. m.	40°	63½°	64½°	63½°
Feb. 23, 1917......	4:15 p. m.	36°	61°	63°	61½°
Feb. 24, 1917	8:00 a. m.	[illegible]	[illegible]	53¾	53¼
Feb. 24, 1917......	12:00 p. m.	59°	51½°	52½°	51½°
Feb. 25, 1917......	11:00 a. m.	53°	45°	45°	45°
Feb. 25, 1917......	1:00 p. m.	63°	46½°	46°	46°
Feb. 26, 1917......	8:00 a. m.	60°	53½°	53½°	54°
Feb. 26, 1917......	12:00 p. m.	62°	56°	55°	55°

TABLE II—READINGS TAKEN AT VARIOUS TIMES UNDER EXTREMES OF TEMPERATURE.

Date.	Time.	Temperature Readings Outside. No. 4	No. 1 Face. East	No. 2 Center.	No. 3 West Face.
June 25, 1917	8:00 a. m.	86°	88¼	86	84°
June 25, 1917......	9:00 a. m.	96°	92°	88°	84°
June 25, 1917......	10:00 a. m.	99°	95¼°	89¾°	85°
June 25, 1917......	12:00 p. m.	101°	96½°	91¾°	87°
June 25, 1917......	2:00 p. m.	99°	94½°	93°	91°
June 25, 1917......	3:00 p. m.	98½°	93½°	92½°	94½°
June 25, 1917......	4:00 p. m.	96½°	93°	93½°	98°
June 25, 1917	5:00 p. m.	[illegible]	92	94°	101½°
June 25, 1917......	6:00 p. m.	92½°	92½°	94½°	104°
June 25, 1917	7:00 p. m.	90½	92¾	95½°	105¼
June 25, 1917	8:00 p. m.	86	92½	96	104
June 26, 1917	8:00 a. m.	96	88½	89½	87
June 26, 1917	10:00 a. m.	100°	98¼	93	88
June 26, 1917......	11:00 a. m.	102°	100°	95°	89°
June 26, 1917......	12:00 p. m.	104	100°	96°	90°
June 26, 1917......	1:00 p. m.	104°	100°	96½°	92°
June 26, 1917......	2:00 p. m.	101°	99°	97°	94½
June 26, 1917......	3:00 p. m.	101½°	98°	97°	96¾
June 26, 1917	4:00 p. m.	98°	97¾°	97½°	100°
June 26, 1917	5:00 p. m.	94	97	98	102
June 26, 1917	6:00 p. m.	92	96½°	98½°	101°
June 26, 1917	7:00 p. m.	90	96	98½	103½°
Jan. 11, 1918......	11:00 a. m.	—1°	10°	12½°	10
Jan. 12, 1918......	8:30 a. m.	—16°	—10°	—8°	—12
Jan. 12, 1918	9:30 a. m.	11	11	7½°	—8°
Jan. 12, 1918......	10:30 a. m.	—8°	—8°	—6°	—6°
Jan. 12, 1918	11:30 a. m.	5°	7½°	5°	5°

Unit Figures for Estimating Cost of Laying Pipe

Useful data on the cost of installing [illegible] pipes have been compiled by Mr. Geo. Wehrle, [illegible] ent of the Gas Department of the Denver Gas & Electric Light Co. These data were made public by Mr. Wehrle in an article in The Gas Age from which the following is taken:

Factors on Which Cost Tables Are Based.—With the idea in view of getting out a universal or standard cost chart on the work of installing underground gas pipes, Mr. Wehrle enlisted the aid of an appraisal engineer, and it was decided that the first and salient factor of such a cost chart must be the man power expended in each class of work and from that factor working to a unit cost for that class of work. It was decided that under average conditions a man would trench and backfill 9 cu. ft. of trench per hour, and that the cost of trenching would equal twice the cost of back filling. The labor cost per hour was fixed at 1 cent, [illegible] unit cost per [illegible] foot of $0.00111

The cubical contents of a bell hole was considered to be that contained within a space of 8 in. wide and 18 in. long extending from a point 8 in. above the pipe to a point 8 in. deeper than the bottom of the trench on each side of the pipe and across the bottom of the trench under the pipe. Reducing this to a formula the cubical contents of a bell hole for a given size of pipe equals:

[illegible] trench).

Dividing this result by 12, which was considered to be the length of a joint of cast iron pipe in feet, gives the cubical contents of a bell hole per lineal foot of trench. Multiplying this figure by 0.00111 gives the unit cost of bell holes per lineal foot.

In finding trenching costs for screwed steel pipe the same unit cost is used as for a given size of cast iron with the omission of the bell hole.

Pavement and crib timbering costs have not been con-

CAST IRON [illegible]

Laying Pipe.

Size of pipe	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Note—To find local costs per foot [illegible]

Jointing Pipe.

Size of pipe	Number of men: Calkers	Yarners	Leadmen	Weight [illegible]: Per joint	Per ft.	Weight [illegible]: Per joint	Per ft.	[illegible]	[illegible]	[illegible]	[illegible]
4	1	1	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	[illegible]	1	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8	[illegible]	1	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	[illegible]	1	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	1	1	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16	[illegible]	1	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20	2	2	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
24	2	2	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
30	[illegible]	2	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Note—To [illegible] local cost per foot [illegible]

Trenching and Backfilling.

Size of pipe	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Note—To find [illegible] the unit cost for bellholes [illegible]

Summary of Unit Costs.

Size of pipe Inches	Labor: Trenching and backfilling: Trench A	[illegible] B	[illegible]	[illegible]	Material: [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	General supervision, en-
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

EXPLANATION OF SUMMARY [illegible]

Column A—Cost per [illegible] per hour.

Column B—Cost per [illegible] foot multiply by local [illegible] local costs of columns A and B equal the total cost of trenching and backfilling of which two-thirds may be charged to trenching and one-third to backfilling.

Column C—Cost per foot [illegible] For local [illegible] per hour [illegible] pipelayer.

[illegible] mile. For local cost per foot multiply by local drayage rate per ton-mile.

Column I. Storage and handling cost assumed to be 1 per [illegible] cost regardless of locality.

STANDARD SCREWED STEEL PIPE

Laying Pipe.

Size of pipe, inches.	Foreman.	Pipemen.	Weight of pipe per ft. in lb.	Weight of pipe per man hour.	Feet of pipe per man hour.	Feet of pipe laid per hour by gang.	Unit cost per ft. at $0.01 per man hour.
[illegible]	[illegible]	[illegible]	2.28	[illegible]	104.2	312.5	$0.000096
[illegible]	[illegible]	[illegible]	2.73	[illegible]	86.6	260.0	.000116
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	65.0	195.0	.000154
[illegible]	1	2	[illegible]	[illegible]	36.6	110.0	.000273
[illegible]	1	2	10.89	[illegible]	26.6	80.0	.000376
[illegible]	[illegible]	[illegible]	19.19	303.2	15.8	47.5	.000633
[illegible]	[illegible]	[illegible]	28.81	302.5	10.5	52.5	.000952

[illegible] handling of the pipe from the curb line to the trench and lowering into [illegible] constant due to the reversing of a variable number of couplings per unit weight [illegible] multiply unit cost by local pipemen hourly wage.

Trenching and Backfilling.

Size of pipe	Width.	Depth	Cu. foot of trench.	Man per hour in cu. ft.	Cost of excavating and backfilling at $0.01 per man hour: per cu. ft. of excavation.	Unit cost per foot.
[illegible]	18"	[illegible]	[illegible]	[illegible]	$0.00111	$0.00166
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00111	.00166
[illegible]	18"	[illegible]	1.50	9	.00111	.00166
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00111	.00166
[illegible]	20"	[illegible]	1.66	9	.00111	.00184
[illegible]	[illegible]	[illegible]	1.83	9	.00111	[illegible]
[illegible]	24"	[illegible]	[illegible]	[illegible]	.00111	.00222

[illegible] and backfilling [illegible]

Jointing.

Size of pipe.	Number of men.	Joints per hour per gang.	Ft. of pipe per hour per gang	Unit cost per ft. at $0.01 per man-hr.
1¼	[illegible]	[illegible]	180	$0.000111
1½	[illegible]	[illegible]	160	.000125
2	[illegible]	6	120	.000166
[illegible]	[illegible]	4	80	.000250
4	[illegible]	3	60	.000333
6	2	2	40	.000500
8	3	2	40	.000750

Note—Jointing pipe covers the work of entering and screwing up pipe in the trench. The number of joints per man-hour varies as the diameter of the pipe. To find local cost per foot multiply unit cost per foot by local wage scale per hour.

SUMMARY OF UNIT COSTS.

Size of pipe. Inches.	Labor: Trenching and backfilling. A	Labor: Laying. B	Labor: Jointing. C	Material: Pipe. D	Material: Drayage. E	Material: Storage. F	General supervision, engineering, contingencies. G
[illegible]	[illegible]	$0.000096	$0.000111	$0.01	$0.00114	4%	10%
[illegible]	[illegible]	.000116	.000125	.01	.00136	4%	10%
[illegible]	.00166	.000154	.000166	.01	.00184	4%	10%
[illegible]	.00166	.000273	.000250	.01	.00381	4%	10%
[illegible]	.00184	.000376	.000333	.01	.00514	4%	10%
[illegible]	[illegible]	.000633	.000500	.01	.00959	4%	10%
[illegible]	.00222	.000952	.000750	.01	.01440	4%	10%

EXPLANATION OF SUMMARY TABLE FOR STANDARD SCREWED STEEL PIPE

Column A—Cost per foot for trenching and backfilling a trench 1 ft. deep at a labor cost of 1 ct. per hour. For local costs per foot multiply by depth of trench in feet and by labor wage rate per hour.

Column B—Cost per foot for laying pipe at a 1 ct. per hour wage scale. For local costs per foot multiply by local wage rate in cents per hour.

Column C—Cost per foot for jointing pipe at a 1 ct. per hour wage scale. For local cost per foot multiply by local wage scale in cents per foot.

Column D—Cost per foot of pipe at 1 ct. Substitute local cost per foot.

Column E—Drayage cost per foot at $1 per ton-mile. For local cost per foot multiply by the local drayage rate per ton-mile.

Column F—Storage and handling cost assumed to be 4 per cent of material cost regardless of locality.

Column G—Supervision, engineering, contingencies, assumed to be 10 per cent of total cost regardless of locality.

sidered, as they are of a very variable character and best handled individually.

The labor of installing pipe, which in the case of cast iron covers the handing of pipe from the curb line to the trench, swabbing out, inspection and lowering into trench, and for steel pipe the work of reversing couplings, handling from curb line to trench, swabbing out, inspection and lowering into trench, was worked out by establishing an amount of pipe in lineal feet that could be handled in a given time by a standard pipe gang composed of a straw boss and a certain number of men for each size of pipe, based upon the weight of a foot of pipe of a given size and the size of gang required to handle a standard length of pipe.

In arriving at the number of men required to handle the pipe it was considered that all pipe under 12 in. in diameter would be lowered into the trench by means of ropes held by the men, while 12 in. and larger would be let into the trench by means of a portable derrick.

A ratio of weight per man-hour was established which in the case of cast iron pipe was found to be approximately 425 lb. of any size of pipe.

The unit cost per foot for jointing cast iron pipe was calculated in the same manner as for laying, except that the weight of lead per joint instead of the weight of pipe per foot was used as a base. The number of men comprising the jointing gang was first decided and then the number of joints that they could make in a given time was calculated by establishing a ratio between the weight of lead and a man-hour. It was found that this ratio was 12.5.

In jointing steel pipe the number of joints per man-hour is considered to vary as the diameter of the pipe which takes into consideration the friction to be overcome in jointing pipes of different sizes as well as the weight of the pipe per foot of length.

The cost of pipe per foot used in the tables is figured at $1 per ton for cast iron and 1 ct. per foot for steel pipe. Lead and yarn are figured at 1 ct. per pound each.

Store expense, which should cover the cost of maintaining a pipe storage yard or warehouse, unloading from cars, checking material, etc., has been estimated at 4 per cent of the total cost of materials. This figure was obtained by checking the cost in several cities, and while it may not hold absolutely true in these days of abnormal prices, will not prove an error of great consequence when it is considered that at this time storage labor cost has also advanced above normal.

Drayage covers the cost of transporting materials from storage yard, warehouse or cars to the job, and is based upon a cost of $1 per ton mile.

Supervision, engineering and contingencies, which includes the time of the general foreman, watchman, waterboy, etc., the cost of preliminary surveys and estimates, running levels, lines, etc., as well as permits and overhead expenses or contingencies not otherwise classified, is estimated as 10 per cent of the total cost of the job.

New York Conservation Commission Recommends That State Construct Power Dams.—The New York State Conservation Commission in its last annual report advocates a water power policy involving state regulation of stream flow by storage reservoirs, the leasing of state-owned power sites to municipalities and power companies, and the generation, transmission and distribution of power by the municipalities or the companies. The commission recommends that the state itself construct power dams upon the power sites owned by the state, as permanent improvements to the sites, and that it then proceed to lease the power privileges at those sites to municipalities or private corporations, leaving it to the Public Service Commission properly to regulate both rates and service.

The Little River Drainage District of Cape Girardeau, Mo., contemplates adding 40,000 acres in Stoddard and Bolinger Counties. The necessary 50 miles of canals will require 1,400,000 cu. yd. of excavation estimated to cost $250,000.

Calaveras Dam Slide—Report on Failure of Hydraulic Fill Dam During Construction

In connection with hydraulic dam construction contemplated by the U. S. Reclamation Service, an investigation of the slide which occurred at the Calaveras Dam of the Spring Valley Water Co., near San Francisco on March 24, 1918, was made by D. C. Henny and Charles H. Swigart, Consulting Engineers of the Service. Their report is printed in the Reclamation Record, to which we are indebted for the matter following.

The elevation and principal dimensions of the Calaveras Dam as originally designed are as follows:

Surface bed rock at center line, 560 ft.
Earth at center line, 590 ft.
Spillway crest at center line, 790 ft.
Top of dam, 800 ft.
Top of dam above surface bed rock, 240 ft.
Top of dam above surface earth, 210 ft.
Top of dam above spillway crest, 10 ft.
Top width, 25 ft.
Water slope, 3 to 1.
Dry slope, 2½ to 1 with one 20-ft. berm 100 ft. below top.
Length at top, 1,300 ft.

The design has been amended so as to raise the top 10 ft. by steepening the upper portion of the slopes, with the object of increasing spillway overflow capacity.

Water control was to be had by a conduit on rock foundation passing through the dam with concrete gate tower near the water toe. An overflow spillway is provided in rock through a saddle near the west end of the dam.

The total volume in the dam is stated as 3,085,000 cu. yd. The intention was to place all the material by the hydraulic process. The material was derived from borrow pits upstream from the dam and on the west side of the reservoir.

The work was started in 1913. Material in the borrow pit was loosened by powder and washed down by giants to a pump pit, from which motor-driven pumps conveyed it through 14-in. steel pipes to the dam. As the elevation of the work increased booster pumps were installed on the pipe line.

The material consists of shale rock, with some intervening layers of sandstone, the rock being overlaid with a few feet of earth. The shale broke up readily by the action of the jet which partially converted it into clay, so that the material as it passed through the pipe and was discharged on the dam consisted partly of rock fragments, the balance being clay. All evidences indicate that there was practically no gravel, and the percentage of sand is also very small, being derived from the breaking down of the sandstone.

The material was delivered to the dam on the outer slopes between which a pond was maintained toward which the coarser deposits sloped and which consisted of pure clay. The relative proportion of these materials has been stated to be about 50 per cent of each. It is thought that this understates the proportion of clay. The mixture as it was pumped passed through the pipes at a velocity of 10 ft. per second without causing serious trouble, and the percentage of solids carried was stated to be from 10 to 15, which would hardly be compatible with a 50 per cent proportion of coarse material. It was stated, however, that the percentage of solids carried was occasionally somewhat smaller.

The original plans for an all hydraulic fill dam were carried out until the pond in the dam had reached an elevation of 45 ft. above stream bed. Early in 1915 some doubt existed as to the ability of the outer slopes to hold the liquid inner core in place, due to excess of clay. Part of the pumped clay was accordingly wasted into the reservoir in an effort to secure a greater proportion of coarse material by the hydraulicking process. The next step was the changing of plans to the extent of dumping dry material on the downstream slope from wagons loaded by steam shovel from a new pit near the west abutment of the dam.

Some time during 1916 a more radical change was made, it being decided to dump dry material on both slopes, the general scheme being to place in this manner about one-third of the mass upstream and one-half of the mass downstream of the center line of the dam. The large amount of material so handled caused a change of conveyance from team to dump cars on tracks laid on trestles and on the dam itself.

The material was dumped loose, no spreading or rolling being done. The toe of the dump toward the inside of the dam projected over into the core and as the work progressed there was an ever-increasing mass which rested on the mud core. The water face of the dam was finished to the slope shown on the plans (Fig. 1), the lower part up to a vertical height of 60 ft. being paved with concrete 3½ in. thick. The original intention of an all concrete paved slope was abandoned at the stated height and for the higher work rough riprap was substituted. The downstream fill was deposited by dumping from cars and the slope was not filled out, but was brought up somewhat irregularly at the angle of repose, with occasional berms, which were to be filled out later by additional material to the intended slope of 2½ to 1.

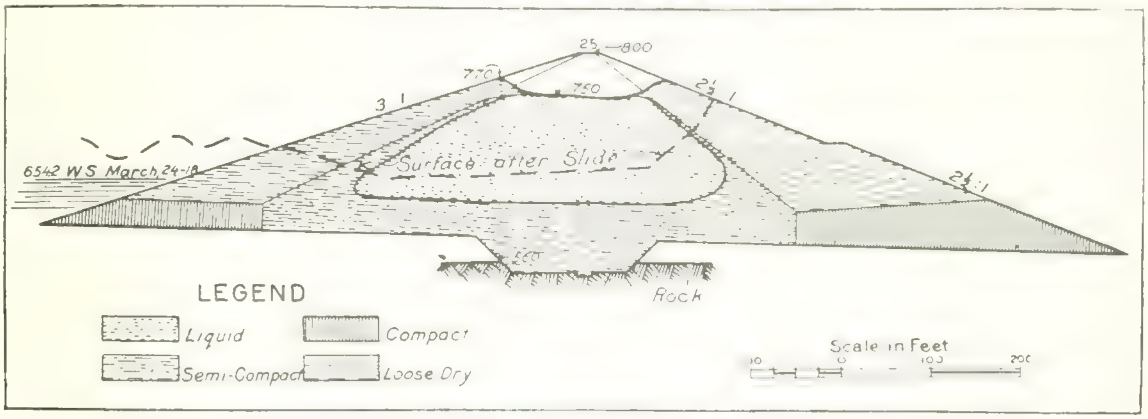

Fig. 1—Cross Section of Calaveras Dam Approximately at Point of Maximum Height.

In this manner the work proceeded until June 18, 1917, when the sluicing operations were stopped, as a movement on the water face of the dam, amounting at some points to 18 in., had been observed. At that time a further movement of part of the water face occurred, of 6 in. in 12 hours. This movement, however, ceased and sluicing was resumed on July 7, 1917, but was again stopped after 12 days' work.

The dumping of dry material on both slopes was continued. The overlapping of this dry mass over the edge of the mud pond resulted in serious settlement, the surface sinking down from 3 to 5 ft. at a time. Coincident with this sinking was a rise in the pond level, which had mounted in September, 1917, when one of the authors visited the work, to over 5 ft. and which subsequently increased to 18 ft.

On Feb. 12, 1918, sluicing was again resumed, but further movement becoming apparent it was stopped on March 1. The maximum movement toward the reservoir [illegible], amounted to 4 ft., until the morning of March 24, when a mass estimated at 800,000 cu. yd. slid into the reservoir.

At that time the core had been carried up so that the outer slopes were within 40 ft. and the pond level within [illegible] of the ultimate top of the dam (elevation 810) and the dam as to earth volume was over 90 per cent complete.

From statements made to Messrs. Henny and Swigert [illegible] noises were heard by a man passing over the dam about 7 a. m. on the day of the slide, who reported also having received the impression that the top of the concrete facing which projected about 12 ft. above the water had fallen out of line. The only observer at the time of the slide, which started at about 7:30 a. m. and lasted a few minutes, was the young daughter of the engineer, who saw the gate tower sway and topple and the front of the dam move out toward the reservoir.

The exact movement of the slide is a matter of speculation. Some of the outer slope material moved toward the reservoir some 600 ft., as is evidenced by a telephone pole which was set in the slope near the top of the dam at its west end and which now stands far out in the reservoir. Much of the water slope material has moved a smaller distance. The entire mass may have moved as a body toward the reservoir with a slightly swinging motion, which caused a breaking away of the body from the east abutment. The space thus opened permitted the mud contained in the pond to flow out into the reservoir. This removed the support from under the dry water face fill, which broke down in large bodies. A roadway which was originally on top of the dam now rests about halfway between its previous position and the water toe and inclines downward toward the center of the dam base.

The mud flow extended to the water line, which was at elevation 654.2, or about 116 ft. below the top of the dry fill and 96 ft. below pond level. In its progress it probably gouged a deeper channel through the outer fill and finally left the bottom of the curved mud channel on a plane reaching from the water level back into the core space at a slope of about 1 to 20.

The moving mass knocked the upper part of the gate tower over, probably leaving its lower part and foundation undisturbed. Some mud entered the outlet conduit, but the inflow appears to have been quickly stopped by deep burial of the opening under the mass which followed.

A cross section of the dam at its highest point as it stands at present is sketched on Fig. 1. It will be noted that part of the loose fill on the dry face of the dam was taken out with the slide. The short upward grade toward the reservoir does not indicate any sliding plane, as the core mud at this point flowed largely in a direction parallel to the center line at the dam and toward the opening at the east abutment.

While the slide itself was unexpected the repeated discontinuation of sluicing and the change in design from an all-hydraulic fill to a partial dry fill, as well as close watch of progressive movement and tests of pond material, indicate that the engineers in charge were cognizant of possible danger.

Typical tests of pond material quoted from a large number are as follows:

Jan. 23, 1915.		March 14, 1916.	
Depth below pond level. Feet.	Water contents by volume. Per cent.	Depth below pond level. Feet.	Water contents by volume. Per cent.
10	77	20	71
20	70	30	73
30	71	40	65
40	58	48	64
50	[illegible]	62	53
60	49	69	46

Tests were also made by forcing a 1½-in. pipe into the core material from a boat. Penetrations were had of from 75 to 90 ft. Later, 6-in. cast-iron ball tests were made, the depth to which such ball sank being 45 ft. while sluicing had been in progress, which reduced to 12 ft. and 5 ft., respectively, 6½ and 8½ months after discontinuance of sluicing. Tests of material removed with an augur from a well driven into the core since the accident occurred gave a water content of from 35 to 45 per cent.

Some additional information may be presented regarding the nature of the dry fill as observed from the borrow-pit and in the dam. It has been described as principally sand rock. Messrs. Henny and Swigert's observation is that only a small percentage is sand rock, and that the rock portion is principally shale. This material as dumped loose may have contained 40 per cent or more voids and in mass may have a weight of about 90 lb. per cubic foot. The fill as it sank down in the pond probably did not become mixed with the clay mud, but drove it bodily down and to the side, causing the pond to rise.

The mud surface, as left after the accident, had cracked from drying, but showed moist a few inches below the surface and had free water standing in the cracks from 1 to 2 ft. down. It could not sustain a man's weight and a lath could easily be made to break through the thin, dry crust and be pushed down its full length.

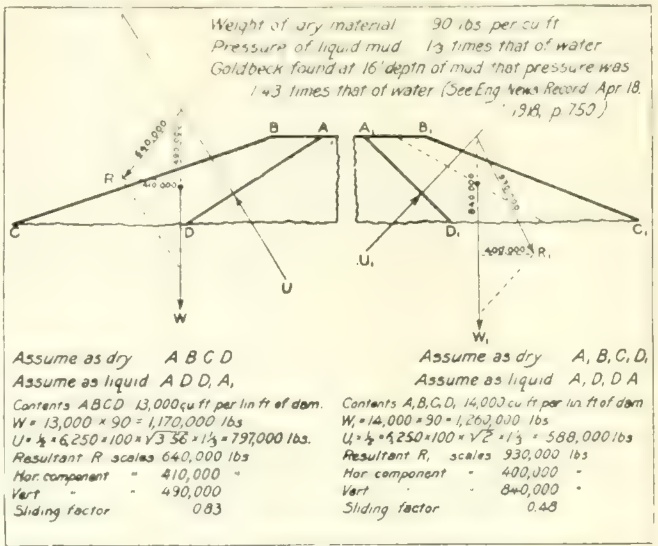
Weight of dry material 90 lbs per cu ft
Pressure of liquid mud 1⅓ times that of water
Goldbeck found at 16' depth of mud that pressure was 1.43 times that of water (See Eng News Record Apr 18. 1918, p 750)
B
A
A₁
B₁
R
640,000
490,000
410,000
C
D
U
W
D₁
C₁
U₁
840,000
930,000
400,000
R₁
W₁
Assume as dry A B C D
Assume as liquid A D D₁ A₁
Contents ABCD 13,000 cu ft per lin ft of dam.
W = 13,000 × 90 = 1,170,000 lbs
U = ½ × 6,250 × 100 × √3.56 × 1⅓ = 797,000 lbs.
Resultant R scales 640,000 lbs
Hor. component = 410,000 "
Vert " = 490,000
Sliding factor 0.83
Assume as dry A₁ B₁ C₁ D₁
Assume as liquid A₁ D₁ D A
Contents A₁B₁C₁D₁ 14,000 cu ft per lin ft of dam
W₁ = 14,000 × 90 = 1,260,000 lbs
U₁ = ½ × 6,250 × 100 × √2 × 1⅓ = 588,000 lbs
Resultant R₁ scales 930,000 lbs
Hor component = 400,000 "
Vert " = 840,000 "
Sliding factor 0.48

Fig. 2—Diagram of Forces.

The extent to which the liquid mud gains in compactness at increasing depth from the surface of the pond can only be surmised from the tests above quoted, the interpretation of which for this purpose is uncertain. It appears that at depths of 60 and 70 ft. the material still remains supersaturated. In order to present at least some attempt at analysis of acting forces our conception of the conditions in the interior of the dam are roughly indicated on Fig. 1.

For purposes of approximate calculation Fig. 2 was prepared, in which the lines AD and A_1D_1 are assumed to represent planes of demarcation between liquid mud transmitting pressure as freely as water and compacted material or loose fill. The rough conclusion which may be drawn on the basis of assumptions made is that a sliding factor of about one-half for the dry mixed rock and earth fill used in the dam is safe and that when this factor reached eight-tenths sliding took place.

The assumptions on which the above study is based are entirely compatible with the fact that the slide occurred several weeks after sluicing had stopped.

The additional dry material which was placed during the interval could have but little influence on the vertical load on any low sliding plane. Its penetration into the mud core, however, had the effect of raising the surface of the mud pond, thus increasing the hydraulic pressure against the slope fills.

Ditch Laws of Ohio to Be Codified.—A commission, consisting of A. G. Fuller of Findlay, O., Frank E. Bailey, Wapakoneta, O., and Perry Ford, County Surveyor of Putnam County, Ohio, has been appointed by the Governor of Ohio to codify the state ditch laws.

Operating Results of Purification Plant of St. Louis

Interesting information on the operation of the water purification plant of St. Louis during the year ending April 1, 1918, is given by Mr. August V. Graf, Chief Chemist of the plant, in his annual report, from which the following notes have been abstracted:

During the year 1917-18, 39,317 million gallons of water were pumped into the basins. To this amount of water were added 1,636 tons of sulphate of iron and 15,608 tons of lime, or an average of 0.58 grains per gallon of the former and 5.56 grains per gallon of the latter.

To the 39,373 millions of gallons of water filtered were added 1,922 tons of sulphate of alumina and 76,352 lb. of chlorine, or an average of 0.68 grains per gallon of the sulphate and 1.94 lb. per million gallons of the chlorine. The aluminum sulphate was added before, and the chlorine after, filtration.

The average cost per million gallons for lime was $2.81, for sulphate of iron $0.55, for sulphate of alumina, $1.12, and for chlorine, $0.27. These costs are for chemicals alone and do not include the cost of handling or application. A comparison of the costs of the various parts of the purification work done during the past 5 years, based on the quantity of water delivered to consumers, is shown in Table I.

The complete purification system was not in use until October, 1915. The heading, November, 1915-April, 1916, is included to show the costs of purification after the system was completed. These figures are included for the year 1915-1916.

Sulphate of alumina was purchased under the same specifications as last year. Basic sulphate of alumina containing not less than 17 per cent of available water soluble alumina, Al_2O_3, was required. Lime was purchased under a specification requiring a lime containing 85 per cent CaO with a bonus or penalty of 1½ per cent of the contract price for each per cent of CaO above or below the required 85 per cent. All lime was sampled as it came from the crusher after unloading and the samples, together with the samples obtained from the daily supply hopper, were analyzed in the laboratory.

TABLE I—COST PER MILLION GALLONS, BASED ON CONSUMPTION.

	1913-14	1914-15	1915-16	Nov., 1915, to April, 1916	1916-17	1917-18
Old Plant—						
Lime	$1.87	$1.61	[illegible]	[illegible]	[illegible]	[illegible]
Iron	1.92	2.02	1.42	[illegible]	[illegible]	[illegible]
Unloading	.11	.10	[illegible]	[illegible]	[illegible]	[illegible]
Operating, maintenance and repairs	.42	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Water, coal, oil, etc.	.11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Light and power	.04	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Chemical work	.28	.25	[illegible]	[illegible]	[illegible]	[illegible]
Basin cleaning	.07	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Basin repairs	...	...	.03	.03	.01	.02
Total, old plant	$4.76	$4.52	$4.37	$3.54	$3.54	$4.69
Filters—						
Aluminum sulphate	....	....	$0.76	$1.00	$0.79	$1.13
Chlorine	....	....	.18	.15	.14	.27
Operating, maintenance and repairs			[illegible]	[illegible]	[illegible]	[illegible]
Coal, miscellaneous supplies and expenses	....	....	.14	.26	.20	.36
Light and power			.14	.17	.11	.21
Total			[illegible]	[illegible]	[illegible]	[illegible]
Total consumption for year in million gallons	30,927	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cost of Chemicals—†						
Lime, per ton, av. 2 contracts	$4.61	$3.48	$3.65	....	$4.49	$6.86
Sulphate of iron, per ton, average	10.00	10.00	10.00	....	12.50	12.81
Sulphate of alumina, per ton, average	....	....	....	....	21.00	22.25
Chlorine, per lb.	.10	.10	.08	....	.13¾	.13¾

*Water used in basin cleaning included 1916-1917 and 1917-1918—omitted other year. †Water used in [illegible] 1916-1917 and 1917-1918—on [illegible] charges connected with the switching of these materials from interchange tracks to Chain of Rocks.

[illegible] 11 per cent of the total [illegible] Over [illegible] per cent of the material [illegible] that it will pass through a 100-mesh sieve. The matter deposited, amounting to 144,230 cu. yd., was flushed back into the river. The chamber was cleaned on an average of once a week, the periods between cleanings varying from four days to two weeks.

The lime was added, for the greater part of the year, to the raw water as it entered the mixing conduit and the sulphate of iron as the water left the conduit. The points of application of the milk of lime and sulphate of iron depended upon the condition of the raw water. With a water high in color and low in turbidity the iron is added before the lime with good results. If the high color is accompanied by a turbidity of 200 to 300 parts or more per million, better results are obtained by adding the sulphate of iron as the water leaves the mixing conduit. With high turbidity, the lime is always added at the first opening and the sulphate of iron at the last. With low color and low turbidity due to colloidal matter, the sulphate of iron is added at the third opening, which allows a mixing through one-half of the conduit.

The coating on the sides and bottoms of the mixing conduit have decreased instead of increasing, as was expected. The unusually large amount of water passing through the conduit at times of maximum pumping, no doubt, was the cause of the removal of some of the coating.

Of the 353,980 tons of material removed from the water during the year by the grit chamber and purification processes, approximately 130,934 tons have been cleaned out in the usual manner with labor and teams. The remainder, excluding the sand removed by the grit chamber, has been flushed out through the sewers by opening the mud gates about 6 in. for a half-hour period at varying intervals and as the basins were drained for cleaning. The heavier matter can not be flushed out, 193,976 cu. yd. of which have been removed during the year from 10 basins in 16 cleanings, at a cost of $2,203.

The water used in cleaning, draining, flushing, etc., has approximately 870 million gallons, being divided as follows: Flushing, 207 million gallons; draining, 299 million gallons; cleaning, 364 million gallons. Filtered water, to the amount of 287 gallons, was used in draining and cleaning and is included in the above given amounts.

The cost per cubic yard of removing the mud from the sedimentation basins was 0.72 ct., and from the clear water basins, 31.3 ct. The costs given are for labor and teams only. No charge has been made for water used in draining, cleaning or flushing.

The presence of macroscopic and miscroscopic organisms, [illegible] in the clear water basins [illegible] during the past year. It has been necessary to keep both of the [illegible] basins at Bissell's Point out of [illegible] days and the Baden [illegible] for [illegible] days, because of the presence of organic growth in these basins.

The large amount of filtered water used in basin operation was due to frequent draining and cleaning of the clear water basins to rid them of the organisms, both macroscopic and miscroscopic, which infested the water in these basins. Since the complete purification system has been [illegible] of the sedimentation basins have become less, but the reverse has been true of the clear water basins. The greater clearness of the water offers a [illegible]

The average comparative turbidities of the river, settled, applied and filtered water were: River, [illegible]; settled water, 24; applied water, 11; filtered water, 0; water to mains, 0.

Although the turbidities of the river water were somewhat greater than for the previous year and a lesser amount of sulphate of iron was used, the turbidities of the settled water is but slightly greater and the turbidities of the applied water is the same. No turbid water was delivered [illegible] Sulphate of alumina was added [illegible] but [illegible] day during the year.

The average color of the river, settled, applied and effluent [illegible] River [illegible], settled 14, applied, 12. [illegible]

The [illegible] of the river water was very low during the [illegible] year, the [illegible] obtained being 15 and the [illegible]. In the latter part of February a rise in the Upper Mississippi and the Illinois Rivers gave us a highly colored water with a turbidity of only 300 parts per million.

[illegible] in the Mississippi and Illinois Rivers and a low stage in the Missouri results in the worst condition for the treatment of the water. The high color of the Mississippi, together with the colloidal matter in the Illinois made the water extremely hard to handle. The use of sulphate of iron and lime coagulant at this time was accompanied with some difficulty. The coloring matter of the water combined with the iron and instead of a diminution in color, the color was increased. The suspended matter being really colloidal and some of the iron hydroxide remaining in the colloidal condition the turbidity of the water after passing through the six sedimentation basins was greater than that of the river.

This highly colored and turbid water was much less amenable to treatment with sulphate of alumina. The amount of sulphate of alumina required to give the required flocculation of the suspended matter was 4 grains per gallon. With this large amount of sulphate, the water passing the filters was clear but still of high color, the iron content being eight to ten times as great as normally. No relief was experienced from this condition until the Missouri River run-off was increased and gave us a turbid water which offered enough suspended matter for the rapid subsidence of the floc of ferric hydroxide.

The total reduction in hardness, due to removal of part of the dissolved bicarbonate of calcium and magnesium present in the river water, was 84 parts per million. For every part per million of lime added there was a reduction in hardness of 0.87 part per million. Fifty-five per cent of the calcium and 47 per cent of the magnesium present in the river water were removed by the added lime.

This reduction in hardness of 84 parts per million means a saving in soap of 95 cents per 1,000 gal. of water used for washing purposes. This reduction in hardness also means the reduction of the scale forming solids from 1.3 lb. per 1,000 gal. in the river water to 0.7 lb. per 1,000 gal. in the water to mains.

The average number of bacteria on agar in the river water was 7.030, and in water to mains it was 11. In the previous years the average of the river water was 8,200 and of the water to mains 11.

The per cent removal of the total number of 20° bacteria was 99.8 and of the 37° bacteria was 99.9.

The water to consumers has been safe at all times during the year. No unusually high counts of bacteria were recorded. The count on agar is the lowest yet attained by this plant.

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40 Cities Propose Spending $123,000,000 for Public Works. Reports made public by the U. S. War Labor Policies Board show that 40 of the larger cities of the country are prepared to spend $122,850,000 in appropriations and bond issues for public works and buildings. In response to inquiries from the board, which was anxious to learn how much buffer employment could be provided for returning soldiers and war workers, mayors of the various cities reported showing that 12 cities in the eastern district were prepared to spend $46,543,500; 13 cities in the central district, $41,248,720; nine cities in the western district, $30,521,000, and six in the southern district, $4,537,000. Among the cities and the amounts reported were:

Seattle	$15,100,000
Philadelphia	13,000,000
[illegible]	11,100,000
[illegible]	8,100,000
Sacramento, Cal.	1,800,000
San Francisco	3,000,000
Salt Lake City	1,150,000
Los Angeles	6,258,000
Tacoma, Wash.	2,455,000
Boston	8,400,000
Buffalo	6,000,000
Pittsburgh	5,150,000
Syracuse	2,362,000

City Home Gardening as a Peace Measure

In a paper prepared for presentation at the 21st annual meeting of the League of California Municipalities, Mr. Levi Chubbock points out the advantages of continuing home gardening work. While his conclusions are drawn from conditions in one city, they are nevertheless applicable to practically all sections of the country. His paper, practically in full, follows.

The National War Garden Commission reports food valued at $525,000,000 grown in 5,285,000 war gardens in the United States in 1918, an increase of more than 50 per cent of what was grown in 1917. In its tabulations, the city of Riverside is credited with nearly 3,000 gardens and crop value of about $60,000, or $20 per garden, although the general average value of crops per garden, as estimated by the National War Garden Commission, is close to $100.

Assuming that these figures are approximately correct, are they of much importance in connection with the world war or otherwise? Can the effort put forth largely by children, some women and a few men have had an appreciable effect in helping to provide food supplies?

Lacking as we have been in this country in ideas and habits of thrift, we often fail to appreciate the importance of the meikles until they are mobilized into muckles, the mills into millions. The Government's Thrift Stamp and War Savings Stamp campaign to secure milions of dollars for war purposes by asking the people to lend to the United States their 25 ct. pieces of money is a striking illustration of the value of the littles when aggregated. And the boys and girls who have grown but a few dollars' worth of foodstuffs in each one of the millions of war gardens have had no small part in the great fight for freedom. Even though the total value of United States farm products for 1918, after stupendous effort by the farmers, with the assistance of all Government facilities, reaches the enormous total of $15,000,000,000, $1 of every $30 of this vast sum will have been produced in war gardens, largely by boy and girl labor done in odd bits of time. And the grand total of $525,000,000 in food values produced in war gardens, as against $755,000,000 put into Thrift Stamps and War Savings Stamps, is a wonderful achievement.

Has Riverside's limit in war garden production been reached? The question has but to be asked, and an emphatic negative will be the answer. As a means of visualizing the situation, let us look for a moment at the garden possibilities of Riverside's Mile Square, the one of its 40 square miles of area that is the most improved. In the 170 blocks in this area there are nearly 2,000 50x150-ft. home lots. Each of these lots contain 1/12 of an acre. If a dwelling and lawn occupied the front 60 ft. of each lot, there would still be on the rear portion 90x50 ft. or 4,500 sq. ft., out of which at least 3,000 sq. ft. should be available for garden and poultry run, which would total nearly 140 acres in the Mile Square that might be devoted to food production, this on the assumption that there was not plethora of business houses, and that all the home lots were made 50 by 150 ft. and were occupied. As a matter of fact, however, there are more than 200 vacant lots in the Mile Square, enough to make up 160 acres of land—a quarter section—that might or should be made available for food production. This area for war gardens could be more than duplicated in each of the square miles of Riverside's area immediately to the north, east and south of the central square and still there would be more than 20,000 acres within the city limits largely available for food production.

But can we extend war garden work without taking too much of the children's time from school work and other home duties, imposing added burdens upon already overtaxed mothers, and interfere with the fathers' business? Yes, if we bring the practice of economy to bear on time, as we are called upon to do otherwise. Probably in no other way do we squander so recklessly as with that precious commodity made up of golden moments that are so priceless that the wealth of the world cannot duplicate them. Yet does any one question if all who live in the Mile Square and are physically able to do garden work, of whom there are probably 4,000, would probably economize their time that at least 2,000 hours could be made available daily for food production work? On the 8-hour basis, that would be the equivalent of the time of 250 men—a force sufficient to carry on a pretty big and very intensive truck farming enterprise.

But what value is there in working out on paper such data based largely on estimates? Will not those who can make war gardens and are willing to do so do it anyway? Well, the Government statisticians evidently did a good deal of figuring on paper to determine how many men between the ages of 18 and 45 would register Sept. 12 for war service, and they came pretty close to the resulting figures. With this and other war measures, it was essential to their success that the figuring be done so as to reach aggregate conclusions as a means of driving the facts home to the people who must meet the issues.

If the boy is father to the man, may not the child gardeners of today be the progenitors of those who will be filled with the same lofty spirit with which the "embattled farmers" were imbued?

The garden is not simply a plot of ground on which to grow things to eat—a place where Aunt Pollys may incarcerate at hard labor the Tom Sawyers when they want to go fishing, or perhaps have filched a huckleberry pie; it is the most wonderful laboratory in all the world in which not only the freshest and best food can be produced, but thrift, health, energy, moral and militant courage, love of beauty, respect for law, and the clearest conception that knowledge is power. Here, under proper and companionable guidance, Nature will unveil her mysteries to the sympathetic soul, so tempered as to gently lead by easy steps from simple but related facts to an understanding of some of her most profound forces and laws, until one is brought to bow in reverence before the Creator.

No other calling brings one into so wide and intimate touch with the forces and facts of life as does agriculture, and none other gives one such command of himself. It requires heroism and sacrifice, and the spirit of the pioneer and adventurer to discover and harness the subtle, yea, the stubborn, forces of Nature that encompass him and permeate his fields to their very atoms and the battle brings out that martial spirit which William James in his "Moral Equivalent for War," says "cannot and must not be tamed within us."

Why is it that of the successful business men of the day, we find nearly 90 per cent were brought up on farms? Because these farm-raised boys were in touch in their homes with a productive industry (a desideratum of educational worth in any home) and were taught habits of thrift, power of observation, quick decision and initiative, and hand and brain were both trained. No other life will so well prepare a child in body, mind and soul for world-wide activities as will that on the farm; and no other scheme of education will so efficiently fit a person for highly specialized work as one which includes the experience of childhood and youth on the farm and a well rounded course of study in an agricultural college. The town and city home garden can and should be made to supply for the urban child, so far as possible, what the farm child is receiving in this particular. Why should not every home in a community like this from which a child goes to the public school be required to have a food production plant (garden and poultry), this to be used by the pupils, educationally, under school direction, as systematically as is the living room of the home for study? Children in apartments? There should be no such animals, and societies for the prevention of cruelty to animals and children should be clothed with legal authority to require that every home in which there are children should have a garden attached, as much so as to have sanitary facilities. And perhaps as an after-the-war measure this will be brought about in the interest of public welfare.

Experience of U. S. Reclamation Service With Large Reservoir Outlets

When the U. S. Reclamation Service began the construction of its first large dams, there were no well established precedents which could be followed in the design of the large-capacity outlet works required, and it was therefore necessary to do much development work before this problem was solved. The data obtained during the course of the earlier developments were applied to later designs and led to some very successful installations. In a paper presented before the Colorado Association of Members of the American Society of Civil Engineers, Mr. James M. Gaylord, Electrical Engineer, U. S. Reclamation Service, discusses some of the phenomena observed and the methods used in overcoming these early difficulties. He also describes one of the most successful later installations. Extracts from his paper follow:

The experience of the United States Reclamation Service in the construction of large reservoir outlets clearly establishes the fact that the design of the outlet channel, pipe or tunnel is of no less importance than the proper design of the regulating devices themselves. In fact, the valves have, as a rule, withstood the service better than the other parts of the outlet works.

Sliding Gates at the Roosevelt Dam.—One of the first head-gate problems was at the Roosevelt Dam, where regulation of the discharge up to a maximum of 3,000 second feet is required, and where the head reached a maximum of 226 ft., measured from the crest of the spillway to the stream bed. In the construction of this dam, the stream was diverted through a sluicing tunnel, driven through solid rock at the south end of the dam about river-bed elevation. The installation includes two sets of three gates each, the down stream set for regulation and the upstream set for emergency closure to inspect or repair the regulating gates. Each gate closes an opening 10 x 5 ft. and is operated by a hydraulic cylinder located in a well extending down from the top of the dam to a point 33 ft. above the flow of the sluicing tunnel. The gate and frame is provided with battered bronze facing strips. The batter of the stationary face corresponds to that of the movable strip, and, when the gate is closed, these faces come into contact. As soon as the gate is raised slightly the load is transferred to roller trains operating between the stationary and the movable track. Under maximum head of 226 ft., the total water load on each gate leaf amounts to 800,000 lb. and on each 4 in. roller the load is 13,000 lb.

Water was turned through the gates for the first time in June, 1908. All the gates were opened wide and allowed to discharge freely for several months, during which time the head reached a maximum of 90 ft. In the following May an examination was made of the tunnel and gates, and damage to the outlet works was discovered. All the roller trains were broken or gone. Some of the deflection plates belonging to the walls above the gates had been carried away or loosened. The bronze gate seats were all damaged by blows from loose parts. Practically all of the nuts and bolts had been loosened, apparently by the vibration, and even the large nuts fastening the leaves to the piston rods were turned, one being 4 in. out of place. The concrete in the roof, floor and piers was badly damaged; a piece about 10 ft. in diameter had fallen from the roof about 20 ft. below the gates. The concrete floor, extending 20 ft. below, had been undercut several feet back toward the piers. Temporary repairs were made, and in an attempt to supply an urgent demand for water the gates were operated for two days. At the end of this time it was found that the entire concrete floor and much of the concrete in the piers had been washed out and in one case a passage made under the sill of a gate.

These results, together with unsatisfactory reports from the operation of sliding gates elsewhere, indicated the advisability of attacking the problem from a different angle. It was apparent that the damage had resulted not only fron.

[illegible] velocity discharge but also [illegible] in the destruction which [illegible] offers to the flow of water. [illegible] received further study, and certain relief measures were taken in connection with the sliding gates at the Pathfinder Dam, which will be described later.

Ensign Balanced Valve Installation at Roosevelt Dam.—At the Roosevelt Dam, however, regulation by means of [illegible] new design were prepared in which the central idea was to produce an efficient device. The new valves are known as the Ensign balanced valves. They have been made in several different designs, the most successful of which is the type for mounting on the face of the dam, completely submerged in the reservoir. Three valves of this type are installed at the [illegible]

The device consists essentially of a cylindrical piston with one end pointed to guide and regulate the discharge. The other end is provided with a bull ring of larger diameter, fitting a stationary cylinder in which it moves. The cylinder is attached to the circular base casting by a supporting grillage through which the water flows in a radial direction. Striking the pointed end of the plug, the [illegible] an angle of 90° and discharged axially through the base casting into the circular outlet pipe. One of the principal advantages of this type of valve is the ease with which it can be controlled. While a sliding gate requires for its operation external power to overcome very heavy forces due to frictional resistance and weight of moving parts, the balanced valve is operated by means of the pressure of the water in which it is submerged, by simply balancing or unbalancing the pressures acting on the movable piston. The resultant is a net opening force on the piston which will slowly move it from its closed position.

If it is desired to close the valve, the outlet from the cylinder is closed, and as the pressure accumulates in the cylinder through the clearance space the valve is unbalanced in the opposite direction, since the pressure in the cylinder is the same as that on the annular ring and the pressure on the pointed end is less than reservoir pressure on account of the velocity of the water. The reaction of the jet also enters into this calculation as an opening force, but the net result is a force tending to close the valve. The balanced valves at Roosevelt have given good service. They have been operated under heads up to 110 ft. during 7 years and are still in serviceable condition. Certain phenomena have, however, been observed in this installation which have been of much assistance in studying the valve problem and which have necessitated further changes in the outlet works. The resistance tube control has proved unreliable as a means of close regulation, owing to the fact that the point of equilibrium is not well defined and a slight accumulation of sediment at any one of the resistance points will disturb the balance and cause a movement of the piston.

Another unexpected difficulty has been the chemical action of the water on the cast iron of the cylinder. The reservoir water contains salt in considerable quantities as well as gases in solution. These chemicals have caused the scaling of the inner surfaces of the cylinder, and the scale thus formed is gradually wearing the cylinder lining and piston and increasing the leakage clearance around the bull ring, making it difficult to open the valves. As they are submerged in the reservoir and therefore inaccessible except at low water, repairs cannot be made when required. It has been decided to install within the outlet tubes steel linings connected to the valves by bronze throat pieces and to extend these pipes through the tunnel to the face of the cliff, where motor-operated needle valves are to be installed. The steel linings are fitted with outside buttstrap joints for both circumferential and round seams, and counter-sunk rivets and patch bolts are used so that the finished pipe will be perfectly smooth on the inside. The space between the steel lining and the cast-iron pipe is to be filled with grout through holes provided for the purpose in the steel lining. Beyond the cast-iron pipes it is planned to continue the outlets as reinforced-concrete pipes connecting with the valves at the face of the cliff.

New Design of Ensign Balanced Valves.—The new valves are of the needle type and are operated by means of a screw and nut driven by a motor. This valve was designed to meet the following requirements: (1) A positive self-locking operating mechanism; (2) no close fits under water except at narrow guides; (3) free access of air to the jet; (4) absorption of energy at a point safely below the works, and (5) a valve accessible for inspection and repairs. The valve has a free opening equivalent to 54 in. in diameter and is designed to produce a clear solid jet with maximum efficiency. The needle is provided with four bronze shoes and slides in a bronze-lined cylinder supported in the center of the water passage by means of radial ribs. The upstream end of this inner, stationary cylinder terminates in a conical casting which serves to prevent impact of the incoming water against the rear end of the needle. The shaft extends through a stuffing-box and is threaded for a bronze nut which operates between heavy roller-thrust bearings. The nut is driven by a motor and worm gear, all gearing being submerged in oil. The end of the shaft is squared to prevent rotation, and is provided with an indicator and limit switch contacts. A certain amount of water pressure can be removed from the needle by venting the space behind the needle, and for this purpose 6 in. motor-operated valves are to be installed.

Sliding Gates at Pathfinder Dam.—At the Pathfinder Dam in Wyoming sliding gates were installed when the dam was built. The installation is, in many respects, similar to that of the Roosevelt Dam, but the gates were of a different type, being sliding gates of very massive construction and special design. The Pathfinder gates have clear openings 3 ft. 8 in. x 6 ft. 2 in., and are operated by hydraulic cylinders 24 in. in diameter. The gate leaves are of massive construction, the frames are very heavy and the piers were lined with heavy boiler plate. The head above the gate sills attains a maximum of 180 ft. with full reservoir, and the discharge has been regulated by means of these gates up to this maximum.

The installation of the gates was completed in April, 1908, and during the summer of that year they were operated wide open. During the season of 1909 the gates were operated at full and partial discharge up to heads of 175 ft. In June, it was discovered that water was backing up in the gate chamber through a 2 in. pipe connecting with the tunnel below the gates, indicating that the tunnel was operating under pressure at this point and that something had gone wrong. The reservoir was emptied in the fall of 1909 and the tunnel carefully inspected. The floor of the tunnel was found to be torn up for a distance of 130 ft. below the gates, the steel plate linings were about one-third gone and a portion of the concrete lining was destroyed. A large slab of rock had rolled into the tunnel, partially blocking it and causing the pressure indications above noted.

A careful study was made of the various phenomena, and it was concluded that the major part, if not all, of the trouble with the gates and outlet chambers could be attributed to vacuum effects of the jet and the resulting vibrations and disturbances. This conclusion was supported by the observation that a discharge through the gates of sufficient volume to cause the sealing of the tunnel below these gate chambers, and the consequent exclusion of air therefrom, would at the same time cause an increasing series of disturbances in the tunnel below these outlet chambers, ranging from tremendous periodic surging of air with an accompanying booming noise resembling distant thunder, to explosive gusts accompanied with peals and detonations of great violence, apparently in proportion to the volume of water discharged and the degree of air exclusion effected. The cure for the greater part of these troubles was very simple and effective. The tunnel was repaired, air was admitted through the lower gate shaft mentioned above, and the discharge limited to an amount which does not seal the tunnel outlet. This has effectually eliminated the vacuum below the gates and the gates have been operated to date, as occasion demanded, without material damage. As regulating devices under heads above 60 or 80 ft., the use of a sliding gate is not recommended, and the operation of these gates for 9 years under head [illegible] up to 180 ft [illegible] a remarkably good showing.

The sliding gates, as a means of regulating the outflow from the Pathfinder reservoir, have been superseded by six balanced valves installed in the south tunnel in the spring of 1912. These valves are duplicates of those installed at Roosevelt.

High Pressure Valves at Arrowrock Dam.—When the design of the outlet works of the Arrowrock Dam in Idaho was undertaken, the experiences at the Roosevelt and Pathfinder Dams were available precedents, and the successful operation of the Arrowrock high-pressure valves is proof that progress has been made toward the solution of this difficult problem. The head at this dam varies from 60 to 230 ft. and the regulated flow reaches a maximum of about 9,000 second feet. The dam is of the concrete gravity type, arched upstream on a radius of 660 ft. The main outlets consist of 20 straight tubes 52 in. in diameter extending on radial lines through the dam, the jets being allowed to fall freely into a pool below the toe. The tubes are arranged in two horizontal tiers, 66 feet and 153 feet, respectively, above stream bed, and each tube is controlled by a 58 in. Ensign balanced valve. Of each set of 10 valves, three are provided with special sleeve controls and are used as regulating valves, while the remaining seven are provided with plain controls and are used only for full open discharge. The lower valves are provided with trash racks while the upper valves have none.

In general design, the valves are almost identical with those at Pathfinder and Roosevelt, but in the method of control of the regulating valves there is a radical difference. In the sleeve-controlled valve, the control pipe connects at the cylinder head with a movable sleeve extending into the main cylinder and operated from a chamber inside the dam by means of shafting and [illegible] opposite the movable sleeve, is an acorn-shaped seat which, when in contact with the inner end of the sleeve, cuts off all outflow from the cylinder. The control shaft is carried inside of the control pipe to the chamber in the dam, where it passes through a stuffing-box and terminates in a crank and indicator. When it is desired to open the valve the sleeve is withdrawn from its seat, which relieves the pressure in the cylinder and allows an opening movement of the piston. This motion continues until the seat approaches the movable sleeve, partially closing the outlet and building up the pressure in the cylinder until the movement of the piston is checked. To close the valve, the control crank is rotated fast enough to keep the sleeve in contact with its seat and the outlet through the control pipe entirely closed while the piston is forced to its seat by the pressure accumulating in the cylinder.

The six sleeve-control valves, all of which are operated at partial opening for regulation, are provided with throat pieces of semi-steel just below the valve and air is supplied at this point through a large number of small holes extending half way around the pipe. The air-inlet castings connect with pipes extending to the top of the dam. The operation of the valves for three seasons under heads as high as 130 ft. has been perfectly satisfactory. The control of the discharge is absolute, and no damage has occurred either to the valves or to the outlets. This excellent record is attributed largely to the efficiency of the outlets, which permits the greater part of the energy of discharge to be passed on and absorbed in the pool below the dam. The perfectly straight alignment of the tubes and the admission of air at the throat of the regulating valves have materially improved the efficiency and have made the satisfactory operation possible.

38,136 Square Miles of Soil Surveys in 1918. Detailed soil surveys covering 38,136 square miles were made during the fiscal year 1918 by the Bureau of Soils of the United States Department of Agriculture. Prior surveys of 445,825 square miles make the total 483,961 square miles. Twenty-two states and four bureaus of the Federal Government are now actively co-operating in soil-survey work.

Office Records of the St. Louis Water Division, Distribution Section[*]

The [illegible] of the [illegible] charge, assistant engineers, superintendents of construction, labor, stables and vehicles, meters, inspection; a chief draftsman, chief clerk and the draftsmen, clerks, stenographers and helpers working under these men.

For distribution purposes, the city is divided into six districts, each having a station building, with a station foreman in charge. The most central of these stations is used as the construction superintendent's headquarters, and is known as the "main distribution office," from which all orders emanate, and to which all reports are sent. Another station, known as the "pipe yards," is used as a supply depot and meter testing station. Each district is divided into sections, in charge of section men reporting to the station foreman.

All material is tested before being used; the pipe, valves, hydrants, special castings and fittings are tested at the place of manufacture, and all other material at the city testing laboratory. The test records are kept at the main office in the city hall. Pipe for contract work is delivered by railroad to depots in different parts of the city, convenient to the work. All other material is stored at the pipe yards and delivered as needed. Records are kept at the pipe yards showing in detail the exact stock on hand at all times.

On receipt of petitions for water mains from property holders on certain streets, or upon notice from the street division that certain streets (without water mains) are to be paved, or when new mains appear to be needed for distribution purposes, record cards are made out, showing the names and extent of the streets. An inspector then ascertains the number and story-heights of all houses on the street, and the kind of pavement, if paved. An engineer then determines the size and length of pipe, number of fire hydrants, valves and special castings needed; estimates the cost of material and labor and total cost, and tabulates these items on the card. The engineer-in-charge will then place on the card a check mark in such a way as to show at a glance whether the work is recommended or not recommended. In a somewhat similar way various requests for additional fire or sprinkling hydrants, private connections, fire lines, etc., are received, considered and either recommended or not recommended. These records are then filed for future reference.

All contract work recommended must be approved by the Board of Public Service and contracts awarded for the work. A record is kept, year by year, of all bids received, and the supply clerk keeps a card index of the current prices of all material used by the water division. On pipe lines, lowerings, etc., the engineers make plans and profiles of the work, stake out the line and enter their notes in the customary engineer's field book. The plan and profiles and a copy of the engineer's notes are then given to the contractor, or in case of work to be done by the distribution section, to the superintendent of construction, with instructions to lay the pipe, castings, etc. On small jobs simple instructions are issued to do the work, accompanied when necessary by sketches and memoranda giving all necessary data. On the larger jobs regular pipe laying inspectors are assigned. On the smaller jobs, the station foremen act as inspectors. Longer jobs (not contracts), pipe laying and pipe lowering are done by pipe laying foremen in charge of what are known as "floating gangs." These men work in all sections of the city, reporting to the superintendent of construction at the main office.

The pipe laying inspectors keep a daily record of labor and material used, and obtain and record measured locations of all pipe, hydrants, valves and special castings, etc. This record is known as the "inspector's notes." On the smaller jobs and routine work the section men fill out a "daily report sheet," ruled in three columns, viz.: "Name," "Place," "Work done and material used." The station foremen obtain and record the measured locations, which, on the "daily report" are collected by the superintendent of construction and brought to the main distribution office. Here, under the direction of the chief clerk, a stenographer types these memoranda into sheets known as distribution notes, if the work is done for the city, and "private connection notes" if done for private parties.

At the end of each month the chief clerk forwards to the chief draftsman a "recapitulation sheet" of all "distribution notes" and "private connection notes" sent down from the main office. This list is checked against the chief draftsman's "posting record," and must agree with it, so that no notes can be lost in transit between offices. The engineer's notes, profiles, distribution notes, and private connection notes are now turned over to the chief draftsman, who numbers the notes serially, and enters them in a "posting book," and is then responsible for the correct platting and recording of the work done on all the drafting room records, and of indexing and filing these records, so that they will be instantly available when needed.

The regular drawings of hydrants, special castings, valves, tools, buildings, etc., are filed in a vertical steel plan file, and indexed in the usual way. Profiles and foreign drawings are rolled up and filed serially in numbered tubes in metal pigeon-hole cases, and card-indexed according to subject matter.

The draftsmen may then post the maps and other records in the following order:

First Posting.—This is done on the distribution map. This is a map of the entire city, on a scale of 1,320 ft. to the inch, on which high-pressure mains are shown in blue and low-pressure mains in red. The size of the pipe is accurately indicated by the thickness of the line; 1/5 in. indicates 48-in. pipe, 1/6 in., 36-in. pipe, 1/8 in., 30-in. pipe, 1/16 in., 20-in. pipe, 1/20 in., 15-in. pipe, 1/32 in., 12-in. pipe, 1/40 in., 10-in. pipe, 1/64 in., 8-in. pipe, a single thin line, 6-in. pipe, and a single thin dotted line 3-in. or 4-in. pipe. No hydrants, valves or special castings, except the separating valves between high and low pressure, are shown on this map. On all other records the size of the pipe and nature of the special castings, etc., are shown by the conventional signs or symbols. Thus, three lines close together, two of them dotted, enclosing a central full line, indicate 48-in. pipe; two full lines enclosing a central dotted line, 36-in. pipe; three full lines, 30in. pipe; one full line and one dotted line, 20-in. pipe; two full lines, 15-in. pipe; two dashed lines, 12-in. pipe; single dashed line, 10-in. pipe; single dot and dash line, 8-in. pipe; single full line, 6-in. pipe; single dotted line, 3-in. or 4-in. pipe, the size being written on the line if necessary. Conventional signs are used for different types of valves, hydrants and other accessories.

Second posting; section maps. These maps are on a scale of 200 feet to 1 in., only 19 being required for the entire city. About 125 city blocks appear on each section map. Cloth blue prints of these maps, mounted on map rollers, are kept at the various stations. These maps are invaluable, especially to the "night station foreman." The numbered separation valves are shown on these maps as well as all other valves, special castings, hydrants, etc. If a water main of any size should burst or a joyrider break off a hydrant and a flood threaten any locality, the foreman refers to the map of the scene of the accident and orders his gang to close the proper valves until repairs are made.

Third posting; loose-leaf plat book. These plat books are on a scale of 100 ft. to the inch, 278 of them being required for the entire city. About 30 city blocks are shown on each plat. On these plats a given city area occupies four times the space it occupies on the second map, and of course shows the pipe, hydrants, valves and other specials far more clearly and distinctly. These plats are consulted on all occasions where exact measured distances, pressures, grades, etc., are not required.

Fourth posting; street intersection cards. These are on a scale of 50 ft. to the inch, over 6,000 being required for the entire city. These cards, when completed, show on one-half of the card the building and curb lines of all street intersections, and measured locations of all water mains, valves, hydrants, etc., within a radius of one-half the distance from the given street intersection to the next nearest street intersection along any street. On the other half of the card are listed references pertaining to the water main, i. e., the engineer's book and page, inspector's book and page, profile number, date of laying, pressure in pipes and grade of street intersection at center lines of street. On the back of the card appears the name of the street, under which the card is classified and alphabetically filed, and on the front the name of the intersecting street. A serial number on the back indicates the place of the particular card in the "run" under which it is indexed. A transparent envelope protects the card from soiling or blurring. These cards are in daily use, answering the thousand and one queries received from the public or from other city departments, where exact and specific information is required.

Fifth posting; separation cards. These are made for all intersections at the boundaries of high and low districts, and differ from the street intersection cards only in that the high pressure mains are shown in blue, and low pressure mains are shown in red, and the numbered separation valves are shown.

Sixth posting; sprinkling hydrants. A very complete and accurate list of sprinkling hydrants is kept. This list shows the number of "Sprinkling Districts," 42 in number, in the city, showing the number and location of the hydrants in each district, the total number of which on Jan. 1, 1918, was 1,894 hydrants.

All additions or removals during the previous year, and deductions to be made on account of oiled streets, and the amount due by sprinkling contractors for the use of the hydrants, are also accurately shown. In addition to this list, all hydrants are shown of a complete city map, scale 1,320 ft. to the inch, divided into sprinkling districts. Each hydrant is numbered, the number appearing on the map adjacent to the hydrant. Enlarged maps of each section on scales varying from 200 to 600 ft. to the inch, are also kept so that the distances between hydrants can be scaled at any time.

Seventh posting; drinking fountains. All fountains are shown on a complete city map, scale 1,320 ft. to the inch. The character of the fountains is designated by conventional symbols for the various fountains installed by the city, by humane societies, saloons, etc., these fountains being for horses and in some instances for dogs or other small animals. Special symbols also indicate special ordinances fountains, metered fountains, or the new type known as "bubbling" fountains, from which citizens may drink when thirsty without danger of contamination. A numerical "District Book" of fountains and an alphabetical card index giving exact location, ownership, date of installation, memoranda relative to the maintenance and care and condition of the fountains, date of withdrawal, etc., are also kept.

Eighth posting; pressure records. Pressure gages are maintained at six carefully selected points in the city, and the charts from them are collected and filed daily, thus keeping, as it were, a finger on the "water pulse" of the city. In addition, numerous special gage-readings have been taken at a number of well chosen points, at various grades, and platted in a city map, scale 2,000 ft. to the inch. By making allowance for differences in grades, we have computed reliable maximum, minimum, and average pressures, for practically the entire city. These pressures are recorded on the "Street Intersection Cards."

Ninth posting; pitometer records. A large number of pitometer readings have been taken at points selected with a view toward determining the direction and volume of the flow, by night or day, from the pump mains into the feed mains, and thence into the distribution mains to the consumer. These readings are recorded on a complete city map, scale 800 ft. to the inch. On this map are drawn three sets of concentric circles, at 1-mile intervals, covering the entire city. The center of one set of these circles is at the Baden High Pressure Pumping Station, one at the Bissell's Point Low Pressure Pumping Station, and one at the Compton Hill Reservoir.

These are the principal records to be posted; and as each record is posted, the draftsman marks on the inspector's or distribution note an abbreviation of the name of the record, as "D" for distribution map; "SP" for sprinkling map, etc. When the notations on the note show that all records have been posted, the chief draftsman O.K.s the note, and it is then pasted in a numbered "gummed stub" book. As the sheets are pasted in, they are paged serially, and index cards made up alphabetically, by street names.

In all municipalities, inherited records are more or less faulty and incomplete, owing in a large measure to continual changes in administration, poor systems in the past, the personal or human equation of the employes, or in some instances, as in that of our own city of St. Louis, to a fire at the city hall some years ago, which destroyed a number of records. It is frequently found that measured locations are either altogether missing, doubtful or evidently incorrect. To remedy this condition as far as possible, two methods were used with great success by the present administration, in the St. Louis Water Division:

1. Copies of the section maps previously referred to were laid out on a table at the main office of the distribution system. The section foremen were then called in, one after another, and, with the chief draftsman, went over the maps carefully and minutely. Where the section man recognized an error, or was in doubt as to any point, notes were made of the error or doubtful condition, and the corrections made when correct information was obtained, by inspectors delegated to this work. A very large number of important corrections were made in this manner.

2. In the drafting room a set of cards known as "Information Cards" (known among the draftsmen and engineers as "I. C." cards), are kept, and on them are entered requests for information on any doubtful point, for corrected locations, or for missing locations which develop in the course of the day's work. On each card is marked the number of the section, from which the information desired is to be obtained; and on the back of the card is marked the name of the street under which the card is classified. On the face of the card is marked the intersecting street, very much as in the case of the street intersection card. The cards are then grouped by sections, the streets being alphabetically arranged in their group. It is then a comparatively easy matter to send out inspectors to obtain the necessary information or obtain it direct from the section man in charge of the section.

By use of these two systems the faulty or missing information cases have been reduced to a minimum, and the value of the record system has been rendered nearly 100 per cent, in the present distribution system.

Engineering Defined*

By CLEMENT C. WILLIAMS

Professor of Railway Engineering, [illegible]

The old definition of Tredgold's given in 1828 and frequently quoted, that "Engineering is the art of diverting the forces of nature for the use and convenience of man," has doubtless done the profession much harm, or, at least, the conception thus expressed has done it harm, because of its incompleteness and inadequacy. It served, perhaps, for the beginnings of engineering, but it should scarcely be used to define the limits or to set the boundaries of engineering at the present time. The definition would more nearly fit the modern profession if it read: "Engineering is the science, art and business of diverting economically the forces and materials of nature for the use and convenience of man," for engineering is all of these.

Engineering is a science because it requires an intimate knowledge of scientific laws and principles for its successful practice. It takes the high potential concepts of pure science and steps them down through its transformers of plans and specifications so that the lay constructor, contractor or carpenter can understand and apply the same. It is an art, for it has to do with achievement. There is a vast deal of difference be[illegible] and knowing how to get the thing done. Engineering recognizes this fact and couples to the knowledge of science the art of achievement. Engineering is also a business, for it has a commercial aspect; it aids its practioner in making a living and it is directly concerned with producing, exchanging and distributing the world's wealth. Moreover, unless a given engineering work is connected up and correlated in the scope of the plans to these phases of economic organization, there is still something lacking in its design. This last sentence perhaps should be amplified somewhat.

Engineering economics has been too narrowly conceived. To select a structure or machine so that the total annual charge or cost consisting of fixed charges, maintenance, depreciation, and operating expenses shall be a minimum is certainly not the sum total of engineering economics. This simple mathematical relationship is neither complete nor adequate. Minimum annual cost is not more important, perhaps it is less important, than maximum annual net earnings. Engineering has been held in rather low esteem, a sort of necessary evil, by capitalists and managers, because it has concerned itself so completely and has been so inextricably associated with the spending of money rather than with the earning of money. More emphasis should be placed on the value and benefits derived from engineering operations and less on the details of spending the money, although the careful study of this latter phase should be by no means neglected. Engineering economics, therefore, should take into consideration the ultimate purpose of the structure, machine or project. Irrigation projects have failed in many instances, notwithstanding the fact that dam, canal, headworks and all other parts were selected on sound scientific and "economic" principles, because the ultimate phase of the problem, namely, the settling of the population on the land, the tillage of the soil and the marketing of the crops, was not considered. Many hyro-electric plants have been failures to a greater or lesser extent not because the plant and machinery were not well designed but on account of a lack of market for the power developed. Railroads have gone into the receiver's hands in many instances not because the grades and alignment were poorly selected, but because there was no traffic or else the location was not properly designed to serve well the traffic that was secured. In these cases, and others might be mentioned, the ultimate relationships were not duly considered.

Another definition of an engineer that contains a grain of truth, and a pound of untruth because of its incompleteness, should be mentioned in this connection. It is: "An engineer is a man who can do with one dollar what a fool could do with two." The fact is that an engineer may be the man who can do well and adequately with two dollars what a fool will try to do with one. If the additional expenditure would make the project in character and scope commensurate with the technical and economic needs of the situation while the smaller amount would not, the niggardly expenditure certainly would not be in accordance with good engineering.

The sum of the matter is that the perspective or point of view of engineering operations should be from the consideration of the ultimate and complete function of the project and its relation to the complicated social and economic organization rather than from its immediate and limited connection as a technical problem, and that students should be taught to seek the complete and final analysis of a problem rather than the immediate, and perhaps partial or fragmentary, application of its principle.

Water Power Possibilities in New York.- Figures compiled by the New York State Conservation Commission show that the state has within its borders and exclusive of the power possibilities in the St. Lawrence River and Niagara Falls, something like 2,656,410 HP., while but 679,119 HP. has been developed. A further study discloses the fact that whereas the state owns or has an interest in sites where [illegible] HP. could be developed, it has only utilized 7,060 HP. On the other hand, private interests have developed only [illegible] HP. at sites which are owned by such interests

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*From the Journal [illegible] Education

Increasing Flow of Water in Drilled Wells by Shooting

BY CHAS. [illegible]

There are many drilled wells throughout the country that do not supply as much water as may be needed on the place. Oftentimes these wells are bored to a depth of from 100 to 200 ft. Frequently the drilling is through solid rock. The water runs into the well through little crevices which may not be large enough to permit water which may be plentiful enough in the rock near the bore hole to flow into the well.

To remedy these conditions, it is necessary to enlarge the cavity at the bottom of the bore hole and to break into some of the larger subterranean courses that may be near the bore hole. Oftentimes a drill bit will pass within a few inches of a good body of water.

It is very easy to make wells of this character furnish an abundance of water at comparatively small cost. A method that I have successfully used to do this is as follows:

I had a tinsmith make a tin container of a diameter that will go down the bore hole and large enough to hold about 25 lb. of 60 per cent gelatin dynamite. The cartridge paper must be removed from the dynamite, which can then be packed solidly into the container. An electric blasting cap is inserted in the dynamite and the top of the container is then closed with the exception of the small hole through which the cap wires protrude. This hole should also be sealed up from the outside to keep water from getting into the charge. It is best in an operation of this kind to use waterproof electric blasting caps. It is also advisable to use insulated connecting wire which should be long enough to reach up to the top of the bore hole where it is connected with the leading wire running off to the blasting machine. The container should have a handle at the top to which may be fastened a piece of wire or binder twine which is used in lowering it to the bottom of the well. When all is ready, the blasting machine is operated and the charge [illegible]

If a test indicates that the supply of water is not yet sufficient after the first blast, it may be repeated. Sometimes this is necessary. If I use 25 lb. of dynamite in my first shot and find a second shot necessary, I usually use 50 lb. the second time.

One unfamiliar with the action of dynamite might assume that charges of this kind would tear out great quantities of rock and obstruct the well. However, I have not found this to be the case. The shot generally springs a pocket about the size of a barrel. This, of course, increases the capacity of the well and the shot also enlarges and increases the number of crevices in the surrounding rock which may be depended upon to increase the flow of water provided there is any additional water supply near where the blast is set off.

It is necessary to use the tin container for well blasting shots because dynamite will not explode under certain water pressure. The container prevents the water pressure from coming in direct contact with the charge. Water does not hurt gelatin dynamite and the charge would go off all right even if not loaded in a container provided the water pressure were not beyond the given limit.

Tonnage on New York Canals in 1918.—The total tonnage on the New York state canals in 1918, according to the report of the State Superintendent of Public Works, was 1,159,270 tons, distributed as follows: By Erie Canal, 667,374 tons; by Champlain Canal, 434,784; by Oswego Canal, 44,681; by Cayuga and Seneca Canal, 7,509; by Black River Canal, 4,932. According to the records, the value of the commerce in 1918 amounted to $34,212,459, as compared with an appraisal of $24,757,077 placed on last year's freight. Also a greater movement of boats through the canal was seen during the year just past, the statistics showing that the total miles traveled by freight boats in 1918 was 576,731 miles as against 474,504 miles in 1917. The report states that there was a greater use of the canal for the movement of high class freight than ever before, and the efficiency of the canal for the carrying of such higher class commodities has been demonstrated. Practically for the first time the waterway was used by such large private enterprises as the Standard Oil Co., the General Electric Co., the Valveline Oil Co. and others.

Personals

F. J. Hager has been appointed Commissioner of Public Works at Rome, N. Y.

John Wallace has resigned as assistant to City Manager Nagle of Wheeling, W. Va.

Lieut. W. H. Steiner, city engineer of Marshalltown, Ia., has returned to that city, having been mustered out of army service last week.

Winters & Dove, civil and hydraulic engineers, Fort Smith, Ark., have dissolved partnership. W. L. Winters has assumed entire control of the office and business of the firm.

Dwight P. Robinson & Co., Inc., the organization of which was mentioned in our Dec. 11 issue, has its offices at 61 Broadway, New York City. In the previous note this address was incorrectly given as Sixth and Broadway.

R. Stuart Royer, formerly city manager of Fredericksburg, Va., has been elected business manager of the Chamber of Commerce of Alexandria, Va., at a salary of $4,000 per year. Mr. Royer is a civil engineer and an expert in municipal management. He resigned as city manager to enter the army service and was recently mustered out of the Engineering Corps of the army.

Ira E. Taylor has been appointed assistant engineer of the Drainage and Irrigation Department, Extension Division of the Kansas State Agricultural College at Manhattan, Kans. Mr. Taylor has just returned from the Engineer Officers' Training School at Camp Humphreys, Virginia. He is a graduate of the Kansas State Agricultural College, class of 1913, and has had a number of years of practical experience in this kind of work. He will specialize in farm drainage.

The Field, Fellows & Hinderlider Engineering Co. has by mutual consent of its members been dissolved, Mr. Fellows having entered the service of the United States as irrigation engineer, Department of Agriculture. John E. Field and M. C. Hinderlider have removed their offices to 517 Kittredge building, Denver, Colo., where they will continue the general practice of civil engineering, as consulting and supervising engineers, with particular reference to investigations, estimates and reports, litigation and supervision of construction.

Obituaries

Charles E. Phelps, formerly chief engineer of the Public Service Commission of Maryland, died Dec. 2[illegible].

William J. Galbraith, a superintendent of construction for the Foundation Co., died Dec. [illegible] at Westmount, Que., aged [illegible].

Industrial Notes

A. W. Greetham has resigned as sales manager of the excavating machinery department of Pawling & Harnischfeger Co., Milwaukee, Wis., and has accepted the position of assistant sales manager for the T. L. Smith Co., Milwaukee.

The Garford Motor Truck Co., Lima, O., announces the selection of J. F. Bowman of Detroit as sales manager, succeeding S. M. Williams, who takes charge of the new Garford department known as the Highway Development Department. Mr. Bowman is well known in the motor truck industry, and though a young man, comes to the Garford company with many years of work in the motor truck field. Mr. Bowman has more recently been identified with the Federal Motor Truck Co., where he acted as director of sales for several years, and during the last period of the war was interested in United States government contract work in connection with the production of Liberty trucks in Detroit.

The Youngstown Sheet & Tube Co.'s annual calendar for 1919 is out and is perhaps the handsomest of the interesting series issued by that company. It contains twelve new views 8x15 inches, in two colors, each showing one of the spectacular operations in a modern steel mill. The illustration on the front page is a night view of the main plant while it was speeded up on war work and flood-lighted as a wartime precaution. This remarkable picture was made from a photographic plate which had been exposed two hours and is regarded as a triumph of night photography. The calendar will be sent to any address on receipt of 4 cents in stamps to pay expense of mailing. Requests for it should be addressed to the Publicity Department, Youngstown Sheet & Tube Co., Youngstown, O.

The Garford Motor Truck Co., Lima, O., announces another new department which will be known as the Department of Branch Supervision, and the appointment of T. B. Fogg as branch supervisor. Mr. Fogg comes from Toledo, where he has been identified in a number of successful enterprises. The handling of large affairs following an extensive experience with railroads and [illegible] problems fits Mr. Fogg particularly for the work of branch supervisor, of dealing through its branch managers with the large clientele of the Garford company. Mr. Fogg's previous connections cover association with the Gould interests as general industrial and immigration agent for the Gould Southwestern Railroads. Later being identified with the Toledo Terminal Railroad as general manager, following which connection he was appointed receiver by the Federal Court for the Toledo Stone and Glass Sand Company, which receivership he carried through to a most successful termination. His headquarters will be at the office of The Garford Motor Truck Co. at Lima, O.

Railways and Gov't Works Monthly Issue

ENGINEERING AND CONTRACTING

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The *articles* in the first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering and contracting field. The *articles* in the first and last issues of each month (1st and 4th Wednesdays) completely cover county engineering and highway engineering and contracting. The *articles* in the third and last issues of each month (3rd and 4th Wednesdays) completely cover steam and electric railway location, design and construction. See the "mast head" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power

Railways and Govt. Works—3rd Wednesday
(a) Excavation and Dredging (c) Harbors and Docks
(b) Rivers and Canals (d) Railway Construction

Buildings and Structures—4th Wednesday
(a) Buildings (c) Ship Construction
(b) Bridges (d) Miscellaneous Structures

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E. & C. Index Furnished Only on Request

Hitherto it has been customary to send the index of our articles to every subscriber. In order to conserve paper the index for the six months ending Dec. 31 will be sent only to subscribers who send a postal card or letter requesting a copy of the index. We will then list your name so that you will receive the index twice each year without the necessity of writing us. It will assist us if those desiring the index will notify us at once.

Some Mistakes of Mr. Burleson in Recommending Government Ownership of the "Wires"

Postmaster General Burleson advocates Government ownership of telegraph and telephone systems, contending that whereas the private companies expect to earn 8 per cent on their investments, the Government will be satisfied with 4.5 per cent or less.

The Government, he says, can borrow money at 4.5 per cent and the implication is that private companies can not.

There are two economic fallacies in Mr. Burleson's argument. First, if the Government enters upon an era of Government ownership it will soon discover that it can not borrow all the necessary money at 4.5 per cent. Second, if the Government will protect public utilities from competition and other risks of loss, as it should, the public utility companies will be able to borrow money almost as cheaply as the Government itself.

Men who have not studied interest rates very carefully are prone to make the mistake of supposing that if every investment were as secure as a Government bond, money would never command a higher rate of interest than the rate on such a bond. That is false reasoning, for there is always a large number of men anxious to command labor, and capable of so managing enterprises as to earn a return on capital that is several fold the interest rate on well secured bonds. So long as the present financial system exists, these leaders will bid more than 4.5 per cent for money, and they will find thousands of investors eager to join them in industrial enterprises that yield 10, 15, 20 or even higher percentages. Consequently a certain percentage of investors seek investments that give reasonable promise of high returns; others seek investments yielding more moderate returns; and still others seek only the very safest investments in high grade bonds and mortgages.

The amount of capital seeking only gilt-edge bonds probably does not exceed 25 per cent of all capital invested in America. At any rate it is only a fraction of the total, and it is practically all invested at any given moment. Patriotism in war times cause great increases in capital loaned to Governments at low rates, but such a condition is abnormal. In ordinary times if the Government were to try to raise, say, twenty billion dollars to buy the railways and "wires," it would soon discover that 4.5 per cent bonds totaling such a sum could not be sold. Hence the fallacy of assuming that the Government can go on raising large amounts of capital by selling 4.5 per cent bonds.

Important as this fact is, there is another even more important. Railways and large utility companies in normal times have usually been able to bond their plants to the extent of half, and often as high as three-fourths their value, thus raising capital at a 5 per cent rate. The remaining capital needed to build the plants has been secura-
[illegible] on which seemed

likely to be considerable in excess of 8 per cent. Where competition, whether government permitted, has failed the in- [illegible] In the case of the telephone and telegraph companies there has [illegible] always there has been actual competition which the Government has encouraged.

Until a few years ago when the Bell telephone system (American Telephone and Telegraph Co.) effected a merger with the Western Union Telegraph Co., the Federal Government, acting under the Sherman law, made those companies separate. When "independent telephone" companies have tried to unite with the Bell system, time and again has the union been prohibited either by the Federal Government or by state governments. In many states, as in [illegible] state laws prohibit the merger of competing telephone companies. That is bad enough economics, but when there is piled upon that risk other risks, is it to be wondered that investors in telephone stocks seek 8 per cent?

It is one thing, however, to seek 8 per cent and it is another to get it. While it is true that the wonderfully well managed American Telephone and Telegraph Co. has paid 8 per cent dividends for many years, how about the dividends of the other telephone companies? It is a well known fact that most of the so-called "independent companies" have nearly starved to death, few of them earning as much as 4 per cent net on their invested capital. Mr. Burleson himself recognizes this fact, but instead of using it to show that telephone investments, taken as a whole, have averaged less than 6 per cent true net earnings on the entire investment, he uses it as an argument for Government ownership. He says that under Government ownership this wasteful competition would be eliminated, but he keeps silent as to the efforts of state public service commissions to eliminate this sort of competition, efforts that have been so often frustrated by the Federal Government itself.

The plain fact is that all this telephone competition can be eliminated by law, without going to the extreme of Government ownership. Many state public service commissions are eager to eliminate telephone competition, and would have done so years ago had it not been for the Sherman anti-trust law.

Mr. Burleson paints a very alluring picture of Government-owned telephone and telegraph plants operated without any interest charges. He says:

"The Government as owner would no more expect to charge for interest on the investment than it would for money invested in postal facilities, navy yards or other public property."

In short, telephone and telegraph rates would ultimately be only high enough to pay bare operating expenses and no more. While this may appeal to those who have not studied economics, it will occur to others to inquire how such a condition can be brought about without either overcharging present users of the wire systems or taxing the general public to raise the money invested in those systems. Doubtless it would be feasible to amortize the entire investment in the "wire systems" in, say, 20 years, by charging more than the cost of service including interest. But does the present generation wish thus to burden itself for the benefit of future generations? The only alternative, if there is not to be an overcharge for the next 20 years or so, is to do just what Mr. Burleson suggests, raise the capital by general taxation. Now this is precisely the porkbarrel method under which thousands of little hamlets have secured monumental postoffice buildings at the expense of the rest of the public. If there is a better method of wasting capital and covering up unwise investments in plant than the method suggested by Mr. Burleson, we have yet to hear of it.

Every engineer knows that no investment in plant is economically justifiable unless it can be shown that, in the long run, it will earn directly or indirectly, at least ordinary interest on the investment. Governments are inclined not only to ignore this economic law, but to ignore its mate also, namely: If any investment in plant will increase the net earnings by an amount equal to or in excess of the interest charges and operating expense incident thereto, then the investment should be made.

When neither of these economic laws is observed, we get just the sort of management that has always characterized the postoffice department. Mr. Burleson is no worse than his predecessors, and all Congresses have been about on an equal level in wasteful appropriations for postoffice buildings, as well as in their wasteful lack of appropriations for labor saving appliances and plant.

In round numbers the investment in the plant of the Bell telephone system is a billion dollars. The annual gross earnings on each dollar of plant investment have averaged about 25 ct.; and the operating expenses, depreciation and taxes have been 18.5 ct., leaving net earnings of 6.5 ct., or 6.5 per cent on the value of the plant. However, the outstanding bonds, stocks and notes have averaged a little less than 85 ct. on the dollar of investment in plant because most of the depreciation reserve has been invested in the plant. The companies of the Bell system have no "watered stock." On this point the editor speaks from personal knowledge.

Since only about one-fourth of the gross earnings are available for interest and dividends, it follows that even if the Government were satisfied with only two-thirds as great net earnings, the resulting reduction of one-third of one-fourth would be only one-twelfth of the present gross-earnings. In other words, the Government would be able to reduce the present telephone rates only one-twelfth, or about 8 per cent. But even this small reduction could occur only upon the assumption that the Government were to manage the operating and constructing forces as efficiently and economically as they are now managed. Who that is familiar with Government operation of anything believes this to be possible?

So long as Mr. Burleson talks in general terms and avoids estimating just what he believes can be saved to the public by Government operation, there is plausibility in his arguments. But this is an economic problem, and no economic problem was ever solved merely by an appeal to theories and qualitative statements. Quantitative facts, dollars and cents facts, must be used in solving an economic problem, but of such facts Mr. Burleson says never a word.

A Common Defect in Management

A common defect of many large companies and of nearly all governments is the inclination to follow precedent, avoiding any experiments. Illustrative of this is the refusal of the railways to build refrigerator cars 40 years ago. G. A. Swift, founder of Swift & Co., conceived the idea that it would be more economic to slaughter animals in the west and ship the dressed meat in refrigerator cars than to ship the live stock to the points of consumption. He tried to persuade several railway companies to build refrigerator cars, but in no case met with success. The railway companies had a great many cattle cars which they wished to continue to use, but they also doubted the economic feasibility of Mr. Swift's plan.

Forced by the opposition and indifference of the railways, Mr. Swift built 70 refrigerator cars and put his idea into practice. Swift & Co. now own 7,000 cars, and that company is only one of several that own great numbers of refrigerator cars.

In a similar manner Pullman conceived the idea of a sleeping car, but, finding no encouragement from the railway companies, he decided to build and operate "sleepers." Only within recent years have any railway companies undertaken to own their own "Pullmans."

When a railway company becomes large and its stock is widely distributed, the president and other general officers usually receive salaries that are not determined by the net earnings. If then, these officers own relatively little or no stock, there is not the incentive to use their wits and to experiment that exists in smaller companies where a large percentage of the stock is owned by the executives. This is the fundamental reason why so many railway companies have shown lack of initiative, and it explains why men like Swift and Pullman have had to develop ideas that the railway companies rejected.

If companies often show lack of initiative and a tendency to let well enough alone, it should surprise no one that governments are much worse in this respect. Stockholders in companies usually have enough knowledge of economics to pay liberal salaries to at least a few of their executives, and without doubt the desire to merit a large salary serves to stimulate a man to some extent. On the other hand, the citizens of a republic are notoriously averse to paying liberal salaries to their executives. A few weeks ago the secretary of the treasury and director general of the railways, McAdoo, resigned. He gave as reason for his resignation the fact that he could not longer afford to serve at a salary of $12,000 a year. Under him were scores of railway executives receiving salaries two to four times as great as his. Small wonder that he quit.

The salaries of some railway executives seem large to most men, but railway salaries are seldom adequate even where they are highest. Moreover, there is too big a chasm between the salaries of the presidents and the chief engineers, for example. The gap between the salaries of chief engineers and division engineers is also too great. The entire engineering staff of every railway is grossly underpaid, considering what depends upon their judgment.

Salaries of executives and designers should bear a relation to the total expenditures that are dependent upon their judgment. Moreover, the incomes of such men should never be fixed, but should be proportionate to their economic performance. Schwab pays Grace, the president of the Bethlehem Steel Co., a million dollars a year. In similar manner Carnegie rewarded Schwab. When the greatest of industrial leaders thus illustrate their belief in "the law of reward proportionate to economic performance" the rest of the world should hesitate to adopt a contrary policy. Yet here we are with our high political office holders drawing salaries far below what the importance of the position justifies. And here we are with countless managerial and engineering positions in railway companies likewise underpaid. The result is either that ambition becomes dormant or that it deserts the fields where it fails to find stimulating reward.

The First Large American City to Own the Street Railways

By a vote of 3.5 to 1 Seattle has decided to buy the existing street railways for $15,000,000. Seattle will be the first large city in America to acquire a complete street railway system. San Francisco owns a few lines in which it has invested $7,000,000, but most of the street car lines are still in the hands of a company.

Owing to their inability to secure an increase in fares, many of the street railway companies in this country are in desperate financial straits. Fares have been recently raised in about 300 cities. Ninety of the 158 cities having a population of 40,000 or more now have increased rates. The highest fare thus far secured is 8 ct., but this exists in only two cities, Sacramento and Wilkes-Barre. In most cases the increased fare is 6 ct.

San Francisco seems likely to follow the Seattle precedent and acquire all the car lines in the city. Unless rates are soon raised in nearly all cities, we shall soon see many another city follow the Seattle precedent, for it is impossible for many traction companies to earn even 5 per cent net on the invested capital under present conditions. We are not speaking of 5 per cent on "watered stock"—of which there is much less than is popularly supposed—but of 5 per cent on the actual cash cost of the street railway systems.

If Seattle will subject her street railways to the control of the Washington Public Service Commission, as should be done, this municipal ownership experiment may prove very instructive to other American cities. But if Seattle insists upon entire "freedom," it is likely to happen that the accounting reports of her street railway department will not be of much value for comparison with those of traction companies in other cities.

7,000 Jitneys Operating in America

Reports to the War Board from 321 electric railways showed that nearly 7,000 jitney buses are operating in America. Of these 5,800 are competing with street railways in 153 cities; and these 5,800 jitneys have a gross annual income of nearly $14,000,000, or about $2,500 per jitney per annum; the number of employes being 8,200.

At the height of "the jitney craze" there were about 20,000 of these buses competing with street railways, but many cities have passed ordinances that either prohibit the operation of jitneys or make their operation unprofitable.

The jitney has at no time been economically desirable where street cars exist. It stole the profitable short-haul traffic from the street cars, and would not carry the long-haul passengers. Hundreds of street railways suffered irreparable losses from this unneeded and unregulated competition before city and state authorities began to exercise their power to protect the public agents known as street car companies. Even yet 153 cities have not become aroused to the point of protecting their own agents—the traction companies.

From the jitney competition one lasting benefit appears to have been derived. Driven by the spur of necessity many traction companies introduced the one-man street car. Not only did this type of car do away with the necessity of a conductor, but, being much lighter than the standard two-man car, it largely reduced the amount of electric current required. This innovation, while not entirely due to jitney competition, was greatly accelerated thereby, thus demonstrating anew the benefit of competition.

One of the greatest problems in political economics today is what to substitute for competition, in order to spur managers to experiment, when competition is done away with to prevent expensive duplication of plant and labor.

Definitions of Engineering

To the Editor: The editorial appearing in your issue of the 1st inst. entitled "Is It Worth While to Attempt to Define Engineering?" was read with interest. In it you point out the patent defect of a definition of engineering formulated by the writer ("Engineering is the science, art and business of utilizing the forces and materials of nature and the abilities of men to promote the welfare and prosperity of mankind"), viz., "that it is not sufficiently specific, for it applies quite as well to an intelligent, up-to-date farmer as it does to an engineer." Granted, for the most part. It is the writer's opinion that the same criticism applies with equal or even greater force to the definition proposed in your editorial, namely, "An engineer is one whose vocation is the systematic study and application of science to the problems of production." The writer's definition mentioned above is a very broad definition of engineering in general and admittedly is not specific enough to fix the limits of the vocation of engineering. It was formulated incidentally in a paragraph whose purpose was to call attention to the inadequacy of Tredgold's definition in expressing the modern conception of an engineer, rather than with a view to defining the vocation of an engineer of today. (See S. P. E. E. Bulletin Vol. VIII No. 6). In fact none of the definitions that have come to the writer's attention appears to have been framed with a view to setting the boundaries of an engineer's functions but rather have been more or less epigrammatic statements descriptive of certain of his ideals and methods of operation.

In his vocation, the engineer stands between the pure scientist, chemist, physicist, mathematician, biologist, psychologist and sociologist on the one hand, and the artizan on the other. He interprets the concepts and findings of the former by means of plans and specifications in terms that are intelligible to the latter, the carpenter of the mechanician, and then directs the application of these principles to the problems of economic construction and production. This applies to a non-military engineer; a military engineer has so little in common with the modern conception of an engineer that his functions cannot be [illegible] cance.

[illegible] writer's conception of the term, defines the province of the [illegible]

[illegible] the principles of science in terms intelligible to artizans and to direct the latter together with the necessary forces of men and other agencies in the application of the same to economic construction and production.

According to this view, the engineer must have sufficient knowledge of pure science on the one hand to enable him to grasp its principles in their entirety and sufficient knowledge of workmen's devices and methods on the other to enable him to express the pertinent principles of the [illegible] the latter. Attention should be called to the fact in this connection, moreover, [illegible] should include not only mathematics and physical and biological sciences, but psychological and social sciences as well, for in the administration of affairs involving the handling of men, the "imponderables," welfare, loyalty, morale, esprit de corps and mental attitude of men are quite as important as are the laws of matter and motion.

C. C. WILLIAMS.

Professor of Railway Engineering, University of Kansas, Lawrence, Kan.

What Is an Engineer?

To the Editor: The articles in your journal of the 1st are very pertinent as to the definition of "What Is an [illegible]

A little reflection will disclose that an engineer may be anything from a mechanic to a scientist by way of a business man, yet not all people in those vocations would be recognized as engineers. At the same time there are many in each of the above classes who would define an engineer as pertaining wholly to themselves.

It would simplify the definition if the word was spelled after the French "ingenieur," which also brings out the thought or phase relative to ingenuity.

W. W. WAGGONER.

Nevada City, Cal.

What to Do with the German Fleet

To the Editor: The papers tell us that they are going to sink this great fleet. Let me ask, how many thousand tons of the finest grade of nickel steel and Swedish iron are in that great display of boats?

Why not junk the whole fleet and use the iron and steel for some construction, spend the money derived therefrom for the education and betterment of mankind?

Melt up and sell the iron and steel, the war has wasted enough, put the matter in the hands of an international committee with orders to sell for junking purposes only; sell a few at a time and when prices are right, so as not to flood the market.

EDGAR A. ROSSITER.

Chicago, Ill.

Work on Welland Canal to Be Resumed.—Work is to be resumed at once on the completion of the Welland Canal, according to an announcement of the Minister of Railways of Canada. It is expected that about 800 men will be employed during the winter preparing for a general reopening of the work in the spring. The estimated cost of the four main contracts of this project was $20,000,000, of which $12,000,000 has been expended. In addition an expenditure of about $8,000,000 additional was contemplated for structures, bridges, lock gates, etc., etc. Of the later sum $1,000,000 has been spent.

Only 178,362 immigrants in 18 months.—Immigration almost ceased during the war. Statistics announced Jan. 12 by the bureau of immigration showed that from April 1, 1917, to Sept. 30, 1918, a total of 178,362 immigrants arrived in the United States and that 123,676 aliens departed.

Construction Features of Government Housing Development at Cradock, Va.

Many unique and efficient methods of construction are being employed at the Cradock, Va., development of the U. S. Housing Corporation. This project involves the building of a complete city, capable of housing 5,000 or more people. The site, a 450-acre tract of farm land, is served in a transportation way by the Virginian R. R. and the Gilmerton branch of the Virginia Railway and Power Co. The entire project calls for the erection of 609 houses, each of which will be a well appointed, substantial home, with all modern conveniences. Each will have a lot ranging from 30 ft. by 100 ft. to 120 ft., according to the size of the home. There will be 50 distinct designs of houses, single and double, ranging in size from four to eight rooms, the majority being six rooms.

Incorporated into the plans for Cradock are definite provisions for beauty and community service. The public buildings, town hall, post office, stores, business buildings and the like will be built around the "town square." The sites for these buildings have been definitely determined upon, but they are not being built as a part of the war emergency construction. There will be a community building and mass athletic field to be known as "Community Green," as well as two churches and one large school building, and a completely equipped hospital. Parks and open spaces will be numerous and spacious in Cradock. As far as possible, building operations are being carried on so as not to injure or cut down trees, and young trees will be planted along boulevards, parkways and streets to supplement present standing timber.

Engineering work on the site of Cradock was begun on Aug. 7, 1918. The grounds were plotted; lots were laid out; parks, playgrounds, town squares and a community green were provided, and a boulevard system encircling the city, which will connect with broad parkways running through the center of the city. Residence streets will be 50 ft., all curbed and drained. Thirty inch sewer pipes run through the city and 16 in. water mains, connected with the Portsmouth (Va.) water pumping station will provide abundant water. Fire plugs at every street intersection will give fire protection.

Before any work was started the contractors prepared careful plans of operations which have been adhered to practically without deviation. The exigencies of certain situations have required additional labor saving devices to be adopted almost on the spur of the moment. But these always are worked out to supplement rather than to conflict with the original efficient plan.

Within the tract there was planned and constructed 3 miles of steam railroad and switches and spurs so located as not to interfere with permanent construction and so distributed that all material is delivered practically on the spot where it is to be used. This railroad connects the Virginian R. R. with the project. It runs through the heart of the city and forms a complete return loop, so that no time or efficiency is wasted in distributing materials. Supplementing the railroad are numerous trucks, tractors and horse drawn wagons.

Before actual building operations could be begun on the permanent work extensive temporary buildings had to be built. A central office building, numerous storage houses, a complete saw mill, temporary housing for the laborers and many smaller buildings were erected. All trees on the site were boxed to prevent injury, and fencing was placed around important sections. At the same time work on barracks, to care for 3,000 workers, with mess halls, canteen and other service buildings, was begun, and now all are completed. These barracks are heated, have running water and shower baths and everything is comfortable and sanitary. The colored laborers have separate barracks, canteen and mess hall. The mess hall is operated on the cafeteria plan and serves over 2,000 meals a day. At lunch, for example, on Dec. 12, 700 men were served in 17 minutes.

The concrete for the foundations is mixed at a central plant having a capacity of 250 cu. yd. per day, enough for the foundations of 25 houses. It is distributed in special dump boxes mounted on wagon bodies which are hauled by caterpillar tractors. It has been found that each of these tractors is as efficient as several teams of horses. These tractors also were used for plowing, pulling down trees and hauling materials over rough ground as well as on roads.

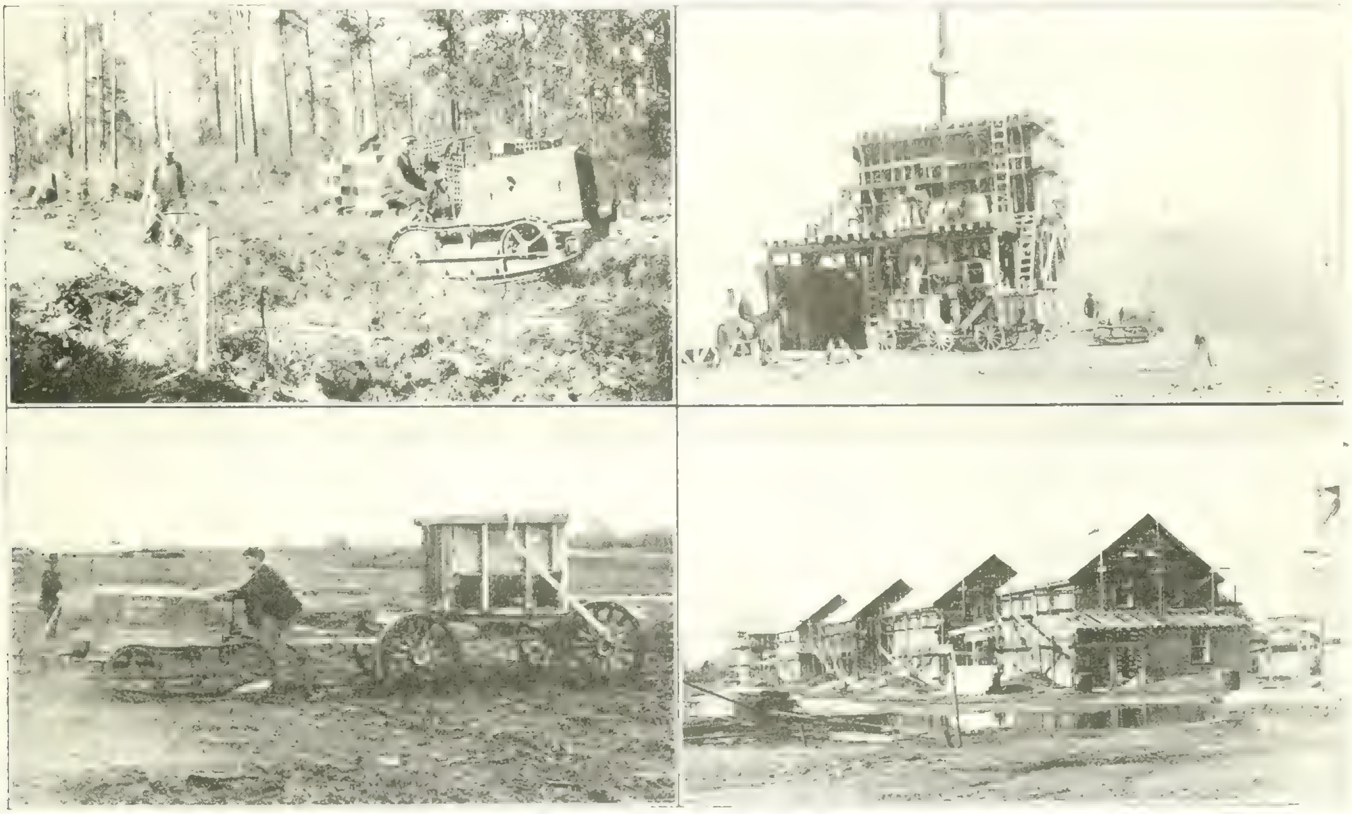
As a sort of "morale stimulator," the contractors have built a tower on their office building, on which has been installed a huge clock marked in colors to show daily progress on the work. This clock can be seen from all parts of the work, its hands pointing, day by day, to what has been done each twenty-four hours.

Once the temporary work was completed, construction of the permanent houses was begun. Indeed, the carpenters have followed close upon the heels of the excavators, and as this is written over 200 houses have been framed, with many under roof and ready for interior completion. An idea of the speed with which Cradock is being pushed, despite a marked and aggravating scarcity of labor, may be gathered from the work on a group of seven apartment buildings, totaling 104 four-room apartments. Foundations for this group were begun on Oct. 23rd. On Nov. 10th one building was completed with plumbing, running water, electric light, all installed and the apartments ready for occupancy. All the other buildings, as far as construction work is concerned, were practically completed on the same day, and turned over to the plasterers, plumbers and electricians. This group of apartment houses marks a new departure in industrial housing. They are 2-story buildings, each containing commodious four-room apartments, with all modern conveniences. They are grouped around a spacious, well wooded court for the tenants.

One of the many "speed" devices is the mill where all framing timber, exterior and interior trim and all door and window frames are cut so that the carpenters on the houses have only to assemble the various pieces and secure them in place. This elimination of petty cutting on the work saves a large amount of time.

Another speed device is the use of temporary platforms upon which lumber is loaded from the railroad cars, and is rolled on the motor trucks, thus eliminating the time that has been the rule when a truck waits for its load. A conservative estimate of this scheme shows that one truck will do the work that would require four if the old method were used.

The plans for Cradock were prepared by George B. Post & Sons, of New York. The engineering work was done by Hill & Ferguson of New York. The entire construction work is being done by the Hegeman-Harris Co., Inc., general contractors, of New York. John W. Harris is in active charge of the work.



Top Views—Breaking Ground for New City. Central Concrete Mixing Plant. Bottom—Tractors Haul Concrete Over 450-Acre Site. Types of Buildings Being Erected.

Labor Saving Equipment Employed in Track Maintenance by B. & O. R. R.*

By E. STIMSON,

[illegible] Superintendent Maintenance of Way and Structures

The steam shovel with the attendant flat cars, plows, Lidgerwood unloaders, spreaders, or dump cars was, perhaps, the first great labor-saving device used on railroads, and is the greatest of all. It made possible the rapid construction and expansion of the American railways and has in itself and with its modification, the steam ditchers, assisted in their maintenance.

Ditching Machines.—The first ditching machine of which I have knowledge was developed on the Illinois division of the Baltimore & Ohio R. R., about 20 years ago, and was called the "Mahoney Ditcher." The first machine was built at the company's shop, and was in use for a number of years. This ditcher is best adapted to work of cleaning out or restoring ditches in standard width cuts. The bucket is shaped to the ditch, leaving it in the finished form with a minimum removal of material. The capacity is about 30 cu. yd. per hour with a full complement of 5 men.

About the time the "Mahoney Ditcher" was brought out, one of another type appeared, namely, a small steam shovel mounted on skids and pulled from car to car along a train

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*[illegible]

[illegible] was rated [illegible] flexible [illegible] It was called [illegible] of the road [illegible] type [illegible] capacity with a [illegible] with these ditchers. This type of ditcher is well adapted to the uses of a steam derrick within the limits of its lifting capacity, and is of great use in unloading and loading rail, ties, timber [illegible] for the dipper arm its uses are still further extended.

Each of these various uses of this machine results in a great saving in man-power, the best example being that of ditching. [illegible] yd per hour in ordinary material. It would require 100 men to load this amount by hand. As it requires but 5 men to operate the ditcher, the large saving is evident. In handling rail 6 men and the machine will readily do the work of 40 men.

In connection with the ditchers there have been mentioned the Lidgerwood unloaders and the plows and spreaders to unload the materials from the cars and spread them away from the track. These are used to best advantage with flat cars, but can also be used with flat bottom, side dump cars. Air dump cars used where the haul is short are economical, requiring a smaller engine for handling and no unloader. They save the time required for switching the plow each time to the rear of the train and the stretching of the cable over the cars, and, not the least important, keep the flat cars in revenue service.

Spreader Cars.—In addition to the equipment for ditching already mentioned there are several good types of steel constructed spreader cars with the wings operated by air which level down and spread out the material dumped from the cars. Two men with a work train crew operate these machines. There is also a type of spreader having, in addition to the long main wing, a short wing in the rear used as a ballast section and roadbed shaper which is a great labor saver where cinders, granulated slag or gravel is used as ballast. These spreader cars are also adaptable for use as snow flangers, as plows and for spreading ballast.

Methods and Appliances for Reducing Work Train Service.—Devices and methods of eliminating work train service in ditching are necessary and often imperative under present conditions. A steel side dump ditching car which is built at the company shops is used for this purpose. It operates on a 22-in. gage track laid directly over the ditch. The car is built low and narrow so as to clear trains in narrow cuts. The capacity of the car is ¾ cu. yd. and can easily be handled loaded by two men. The material loaded is taken to the end of the cut and used for bank widening or is wasted. Where the work is heavy and the haul long, two and sometimes three cars are handled in trains by a motor car. With this method a larger gang is employed and a switch is put in at the end of the cut so two trains of cars can be handled, one loading while the other is being taken out for dumping.

Horses furnish another means of saving work train service. We have found that, including plowing, a 1-horse scoop and driver working in a clay cut averaging 4 ft. in height, and wasting the material on top of the cut, can handle 45 cu. yd. in 9 hours. Another man is required for dressing up the ditch. The two men and one horse, therefore, do the work of at least 10 men. Up to a 300-ft. haul the wheelbarrow is a good proposition as compared with other methods. While these methods may not show great economies over the steam ditcher and work train, and do require much greater time for completion, they are to be recommended where the matter of quick completion is not vital. They require but a small number of men and give steady employment, which promotes efficiency. With the intense traffic conditions prevailing and the great demand for train crews and engines to handle the business it is most desirable to release all the work train service possible. The cost of this service has increased about 40 per cent during the past year and nearly 100 per cent in the past 10 years. These considerations make it desirable, both from necessity and from the standpoint of economy, to adopt methods to reduce work train service.

Rail Handler.—A home made device which has proven a great labor-saver is an air-operated rail handler. With it a gang of six men and a foreman will load one rail per minute. By hand methods 20 men will load 1 rail every 2 minutes on to flat cars and one rail every 5½ minutes on gondolas. The machine is also used for handling frogs, switches, ties, scrap and other maintenance materials with proportionate labor savings.

Labor Saving Machines on Track Work—More labor is used in surfacing and lining of track than on any other item of track work. Normally this will amount to about 35 per cent of the total track payroll. This offers an attractive field for labor saving. About four years ago pneumatic tie tamping machines were introduced for this work. The earlier machines were limited to two tampers, but the later ones have the necessary power to operate four tampers with a consequent reduction in overhead and operating expenses. Our experience indicates that with a 2-tool machine 5 men do the work of 9 men tamping with picks and with a 4-tool machine 7 men will do the work of 17 men without them. There is also an indirect saving made by the more uniform and permanent work done by the tamper, requiring less frequent re-tamping than when the work is done by hand.

Ballast Cleaning Appliances.—Stone ballast, to be fully effective, must be kept clean and the voids unclogged. Where traffic is heavy, particularly on grades, stone ballast will require cleaning at least once in three years and in many places much oftener. To raise the track on dirt ballast and dress off with clean stone is poor practice, and to clean it by forking it over is slow, expensive, and requires a large number of men. A number of methods for cleaning ballast have been considered, even to a gigantic vacuum cleaner which, on account of cost, is out of the reach of most of us. The most practical is the ballast screen. The standard performance with 3 screens and 12 men and a foreman is 200 ft. of double track per 10-hour day. To clean with forks, this length of track would take the same number of men 2.8 days or 36 men with forks to do the work of 13 men with the screens.

Removal of Grass and Weeds.—Much labor is applied each year to the cleaning of grass and weeds from the track and roadbed. Two methods have been more or less effective as "weed killers," burning, and spraying with a solution of arsenite of soda.

About 10 years ago a western railroad designed a weed-burning machine. A strip 7 ft. on each side of center line of track was burned at an average cost of $9.46 per mile. Two burnings were necessary, so that to destroy the weeds the cost would be $18.92. As compared with hand labor it was claimed to save 14 men per day.

The spraying method has been extensively used. In 1916 the cost of spraying 744 miles of single track averaged $18.11 per mile. Including the train crew the work was done by 10 men, averaging 21 miles per day. To do a like day's work by hand where the growth was medium heavy in soft ballast 273 men would be required at an average cost of $23.25 per mile. A large saving in men is thus effected, though not so much in money.

Rail Sawing Machines.—The battered and worn ends of otherwise very good relaying rail makes the maintenance of the rail when relaid difficult, resulting either in poor track or a large expenditure of labor to keep it up. This labor expenditure can be reduced to normal if the smooth ends and the full section under the head, insuring a good angle-bar fit, are restored. This can be done very well by sawing off and redrilling the ends. Machinery for this purpose is to be had, consisting of a steam power plant, high speed cold friction saw and drill presses mounted on a flat car for ready transportation. With a full supply of rail on hand from 300 to 350 rails can readily be sawed and drilled per day. Most excellent results are obtained from rail treated in this manner, which, when laid with new angle-bars and well matched as to height, rides about as smoothly as new rail.

Motor Cars for Section Men.—One of the most widely exploited of the labor-saving devices is the section motor car. It undoubtedly makes possible a reduction in the number of men required to maintain a section of track, and the longer the section and the larger the gang the greater is the saving, by reducing the time going between headquarters and the work. The motor car also greatly increases the range of activity of floating and extra gangs and avoids the use of work and regular trains for transporting the men, with the attendant delays and frequent overtime allowance. The use of the smaller inspection cars by supervisors, master carpenters, signal maintainers, enable them to give more frequent and more detailed inspection and supervision to their work with attendant economies and labor savings.

Devices for Cleaning Away Snow and Ice.—The broom and the shovel are effective, but are required in large numbers with a man to each one. On the line snow plows of the various types and snow flangers take the place of multitudes of men in their accomplishments. Around interlocking plants and switches and in terminals certain thawing devices are effective. In an emergency a yard engine equipped with a sufficient length of steam hose, using live steam from its boiler, will thaw out switches with great rapidity which otherwise would require a large number of men. Steam pipe and gas jets are sometimes used under important switches in busy terminals. It would be difficult to estimate the savings in labor made by the use of snow-cleaning devices as the work is generally done under abnormal conditions, making the keeping of reliable cost data impossible. It is apparent that these savings are considerable.

Minor Labor Saving Devices.—The foregoing descriptions are those devices and methods the use of which makes for big savings in men. There are also many devices of more or less worth, but of minor importance as labor-savers. Some of these are:

Track dolly (running on one rail, for trucking a tie or two at a time, a keg of spikes, and, by use of a box attachment, small quantities of ballast, etc.); tool grinder; tie spacer; machine for driving down screw spikes and lag screws; rail layer (a small portable hand crane for laying rails in position in track, taking the place of tong men); rapid nut tightener for track bolts; rail benders; switch point straightener; an attachment to a motor car to mow grass and weeds for a limited distance each side of the track; portable tie and timber dapper; rail joint expander (saving the labor of driving back the rail); milling machine for milling a pocket in the stock rail of switches to protect the point from wear and reduce renewal costs.

Breaking Up Brick and Cement Block With Dynamite

Dynamite was successfully employed in breaking up a brick and cement foundation for heavy machinery. The base was a solid mass 8 to 10 ft. deep. The method used was as follows: Eight holes 5 ft. deep were drilled vertically into the block. Small charges of dynamite were loaded in the holes and well tamped in. Electric blasting caps were inserted, in all eight charges, and by means of the wires connected up in series on the surface so as to get the cumulative effect of a combination shot. As there was a large skylight less than 30 ft. from the base besides other machinery nearby in the room, it was necessary to cover the bore holes first with burlap bags and afterwards with some heavy pieces of timber to prevent flying pieces of masonry from causing damage. When all was ready, the charges were connected up to a blasting machine and fired. The result was that the block of masonry was shattered so that the various pieces could be handled and carried away by laborers. Two hours' work of one man and a dollar's worth of explosives were required for the job.

U. S. House Passes Bill Validating Verbal War Contracts.—The House of Representatives on Jan. 9 passed the Dent Bill providing for validation of war contracts estimated at $2,700,000,000.

Temperature Records of Cold Weather Concrete

A simple and inexpensive method for securing temperature records of cold weather concrete is described by Mr. L. J. Towne in the December Stone & Webster Journal. The tests were made during the winter of 1917-18 in connection with concrete building foundation work. One purpose of the test was to secure data on the amount of protection necessary to prevent concrete from freezing before setting can take place. The apparatus used in measuring the temperatures is illustrated in Fig. 1. It consisted of a tin tube closed at one end, in which was placed a quantity of kerosene oil, a chemical thermometer, a wad of cotton waste and a rubber stopper. The tubes were buried in the wet concrete with the stoppered end exposed either at the top surface of the concrete, in which case the tube was set vertically, or through a hole cut in the form, in which case the tube was set at an angle of about 45°. The tubes were, of course, lost in the test, but the thermometers and stoppers were recovered so that the net cost for material was nominal. The tubes were set and readings taken by the inspectors on the work without extra expense or special effort. Readings were taken by drawing the thermometer through the hole in the stopper by means of a wire until the mercury was exposed. It is thought that the rubber stopper and the plug of cotton waste effectively insulated the thermometer from the outside air and that the thermometer readings indicated with reasonable accuracy the average temperature of the concrete immediately adjacent to the tube.

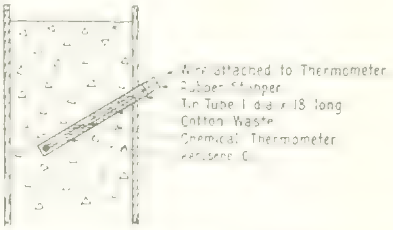

Fig. 1—Apparatus for Measuring Temperature of Concrete.

The concrete for the work was all machine mixed in a machine of ½ yd. capacity. The mixing water was heated and live steam was blown into the drum of the mixer continuously during the mixing process from a pipe extended into the drum parallel to the water supply pipe. This method was very effective in eliminating frost from the aggregate and heating the entire mass to the desired temperature, although a considerable portion of the aggregate was so frozen as to require the use of a pick to loosen it from the pile. In severe weather, however, it often required turning the mixer for 3 or 4 minutes after all materials were in the drum in order to bring the temperature of the concrete to 45° or 50° F.; and it would probably have been more economical to have heated the aggregate in one of the more customary ways.

Three tests were made on column footings. The ground was frozen solid and was excavated with great difficulty. The concrete was poured against the earth without forms and was covered with about 4 in. of stable manure. All three curves for these tests indicate a slight decrease in the temperature of the concrete, notwithstanding the great difference in temperature between the concrete and the outside air.

Three tests were made on comparatively large masses of concrete 6 ft. thick and 10 ft. high. The outside temperatures in the case of two tests were considerably lower than for the previous tests; consequently there was no increase in the temperature of the concrete. Neverthless, the heat generated by the concrete in setting was sufficient to maintain a temperature approximately 20° F. above that of the surrounding air with no other protection than a tarpaulin covering the form.

Two tests were made on relatively small masses of concrete being the first pouring of a basement wall 1 ft. 9 in. thick and [illegible] in height up to the construction joint. The graph shows that this concrete was unable to maintain its temperature against that of the surrounding air and quickly dropped to the freezing point. Arrangements were made to pour the balance of the wall and to protect the wall by means of tarpaulins and manure, but a rapid rise in the outside temperature made such precautions unnecessary.

Figure 2 illustrates the behavior of a wall which, contrary to the instructions of the engineer, was poured without protection because the weather seemed very favorable at the time of pouring. During the following night, however, the temperature dropped 20° and on the third day following, the wall was frozen to a considerable depth. The concrete exhibited the peculiarity of frozen concrete in that it appeared to be thoroughly set. It required an hour's effort to cut out a piece as large as a baseball, which, however, upon being placed in warm water, disintegrated immediately. The wall was covered with tarpaulins and live steam introduced underneath, but it required considerable effort to raise the temperature of the wall above the freezing point, and the rate of setting was evidently not sufficiently rapid to cause any increase in temperature as a result of the setting process. It seems reasonable to assume in the light of the other tests that, if the wall had been given reasonable protection at the start for a period of 24 hours, the setting process would have maintained the temperature above the freezing point.

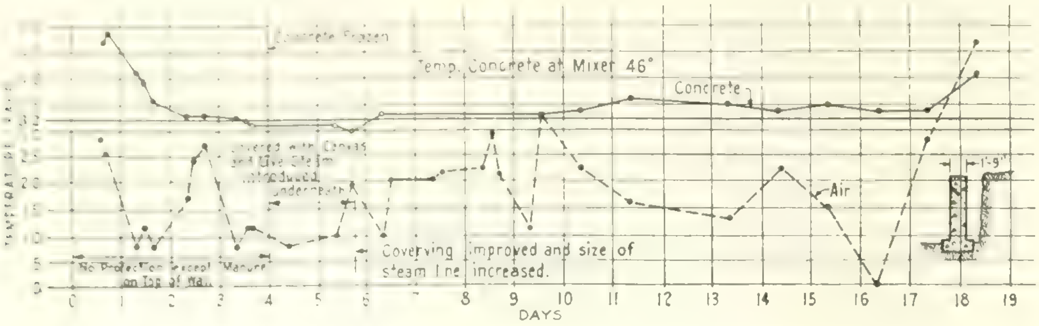

Fig. 2—Curves Showing Behavior of Concrete Placed During Freezing Weather.

In general all tests illustrated the well known property of concrete whereby heat is generated as a result of the chemical reactions incident to the setting of the cement. It was evident that concrete, even in relatively small masses, does not follow the daily variations in air temperatures, but lags behind very considerably due to the large amount of heat necessary to change the temperature of the mass. These two factors together give concrete considerable natural resistance against freezing, and it is probably these factors which have enabled so much concrete poured during cold weather to come through in fairly good condition in spite of careless handling and inadequate protection. To take proper advantage of this natural resistance, however, it is necessary that the concrete be placed in the forms at such a temperature that setting can begin at once and that it be given immediate protection from the outside air to enable the action of setting to get well under way.

These simple tests seem to indicate that it is entirely feasible to record the temperatures of concrete, after pouring, without special expense or effort. Such records will often be of considerable value in indicating the efficiency of any given means of protection or other precaution against freezing. The tests are not sufficiently extensive to warrant any general deductions regarding the amount of protection required to prevent the freezing of concrete under various conditions. With a larger number of tests under more varied conditions, it might be possible to formulate certain general rules for protection more definite than those at present available.

Blasting Costs in American Quarries

In a bulletin, "Rock Quarrying for Cement Manufacture," issued last fall by the U. S. Bureau of Mines, Mr. Oliver Bowles cites the following examples as being fairly representative of the blasting efficiency attained in American quarries where rock is obtained for the manufacture of Portland cement.

Example 1: Conditions.—Limestone is thin-bedded, with a few open joints; churn-drill holes are 5 in. in diameter and 90 ft. deep, with 17-ft. spacing and 26-ft. burden, and are arranged in a single row, 12 to 20 holes being fired at one time, continuous charge of "40 per cent" dynamite is used, with three electric detonators in each hole; secondary shots are chiefly by block-holing method; steam-shovel loading.

Result.—Approximately 4 to 5 tons of rock is obtained per pound of explosive, including secondary shots.

Example 2: Conditions.—Limestone dips 35° to 40°, has some open bedding planes and a few joints; quarry face is perpendicular to strike; churn-drill holes are 60 to 80 ft. deep, with 16-ft. spacing and 20-ft. burden, 12 to 20 holes being fired at one time in single row; charge is continuous, "60 per cent" dynamite being used in bottom of hole and "40 per cent" dynamite for main part, and is fired with detonating fuse; rock is loaded by hand.

Result.—Approximately 3½ to 4 tons of rock is obtained per pound of explosive, not including secondary blasting.

Example 3: Conditions.—Cement rock is thin-bedded in upper 20 ft., with solid ledge beneath; churn-drill holes are 145 ft. deep, with 18-ft. spacing and 20-ft. burden, 10 to 22 holes being fired at one time in single row; continuous charge, mainly "40 per cent" dynamite, "30 per cent" dynamite used near top, four-electric detonators used in each hole; steam-shovel loading.

Result.—About 3¾ tons of rock is obtained per pound of explosive, including secondary shots.

Example 4: Conditions.—Limestone lies flat, is thin-bedded near top, but otherwise sound; 20-ft. face; 8 to 20 5-in. churn-drill holes arranged in two rows and staggered are fired at one time; continuous charge of "40 per cent" ammonia dynamite, fired with electric detonators; steam-shovel loading.

Result.—Average for several years is 3.9 tons of rock per pound of explosive, including secondary shots.

Example 5: Conditions.—Limestone lies flat, is thin-bedded but fairly sound; 60 to 70 churn-drill holes 19 ft. deep are shot at one time, the holes being in two, three, four, or six rows, and staggered; "blanket" blasting; continuous charge of "60 per cent" nitrostarch blasting powder, fired with two No. 8 detonators in each hole; steam-shovel loading.

Result.—About 4 tons of rock is obtained per pound of explosive, including secondary shots.

Example 6: Conditions.—Limestone dips at low angle, is thin-bedded, with few open and many closed seams; 25-ft. face; about 20 5½-in. holes, with 10-ft. spacing, arranged in two rows and staggered are fired at one time; [illegible] by tripod drill holes in hard bed; broken charge of 40 per cent "straight" nitroglycerin dynamite is used, with intermediate stemming in soft bed, two electric detonators are placed in bottom charge, and one in top charge; steam-shovel loading.

Result.—About 3 tons of rock is obtained per pound of explosive, including secondary blasting.

Example 7: Conditions.—Limestone lies flat, is thin-bedded near surface, thick-bedded below; 30 to 35 ft. face; 20 to 30 churn-drill holes, with 12-ft. spacing and 12-ft. burden, arranged in two rows and staggered are fired at one time; continuous charge of "60 per cent" gelatin dynamite, with electric detonators, is used; secondary blasting is mostly by "mud-capping" method.

Result.—About 2.7 tons of rock is obtained per pound of explosive, including secondary blasting.

Example 8: Conditions.—Limestone lies flat, is thick-bedded, with few seams; 22-ft. face; an overburden of clay 2 to 4 ft. thick is shot down with rock and included in tonnage, about 50 4-in. churn-drill holes, with 7 to 10 ft. spacing and 12-ft. burden, arranged in two rows and staggered are fired at one time with electric detonators, 60 per cent "straight" nitroglycerin dynamite used; steam-shovel loading.

Result.—About 2½ tons of rock is obtained per pound of explosive, primary blasting only.

Example 9: Conditions.—Limestone lies flat, is thick-bedded; 30 to 50 ft. face; 20 to 30 churn-drill holes with 18-ft. spacing and 18-ft. burden are shot at one time in one row, with occasional holes closer to face and staggered; 60 per cent "straight" nitroglycerin dynamite and electric detonators are used for primary shots; secondary blasting is nearly all by block-holing method, using hammer drill and "40 per cent" dynamite; steam-shovel loading.

Result.—About 2.6 tons of rock is obtained per pound of explosive, including secondary blasting.

Example 10: Conditions.—Limestone lies nearly flat, is thick-bedded, has some open bedding seams and some open joints; 70 to 80 ft. face; 20 to 40 churn-drill holes arranged in two rows and staggered are fired at one time; first row has 18-ft. spacing and 15-ft. burden, second row has 18-ft. spacing and 14-ft. burden; for primary shots broken charge of 60 per cent "straight" nitroglycerin dynamite with intermediate stemming, fired with detonating fuse; secondary shots are mostly by block-holing method, "40 per cent" dynamite being used; steam-shovel loading.

Result.—About 4 tons of rock is obtained per pound of explosive used for primary blasting only, and 3.6 tons per pound of explosive including that used for secondary blasting.

Example 11: Conditions.—Limestone beds dip about 30°, have a few open seams and clay pockets; 80-ft. face; 18 to 40 churn-drill holes are drilled in single row, with 20-ft. spacing and 20-ft. burden, holes extend 3 to 5 feet below quarry floor; a little "80 per cent" dynamite is used in bottoms of holes, main part of charge is "60 per cent" dynamite and "40 per cent" dynamite, electric detonators are used; rock is loaded by hand.

Result.—About 5 tons of rock is obtained per pound of explosive, primary shots only, and 2½ tons, including secondary blasting.

Example 12: Conditions.—Limestone beds lie nearly flat, upper 20 to 30 ft. are jointed, but rock beneath is sound; 40 to 60 churn-drill holes with an average depth of 95 ft., arranged in one row, or two rows staggered, spacing 16 to 22 ft., burden 36 ft., are fired at one time; charge is mostly "60 per cent" low-freezing dynamite, about one-fifth of the charge being of lower grade, and is fired with detonating fuse; steam-shovel loading.

Result.—About 5.8 tons of rock is obtained per pound of explosive, primary blasting only.

Example 13: Conditions.—Limestone is thick-bedded and dips 10° to 15°; 24 churn-drill holes 5⅝ in. in diameter and 56 to 121 ft. deep, with a spacing of 16 to 17 ft. and a burden of 22 ft.; also 34 "snake holes" 16 ft. long are drilled; churn-drill holes contain broken charges with 12 ft. of intermediate stemming, "60 per cent" gelatin dynamite and "30 per cent" dynamite are used in about equal quantities, the charge being fired with detonating fuse.

Result.—About 4.2 tons of rock is obtained per pound of explosive, primary blasting only, rock well broken.

Example 14: Conditions.—Limestone beds lie flat, have many clay seams; 50-ft. face; 50 per cent "straight" nitroglycerin used in 5⅝-in. churn-drill holes, burden and spacing variable on account of seams; steam-shovel loading.

Result.—About 3.8 tons of rock is obtained per pound of explosive, including secondary blasting.

Examples of Actual Quarry Costs.—The following additional examples of actual quarry costs of interest are also given in the Bulletin:

Example 1: Conditions.—Bench quarry, no stripping, limestone dipping at a high angle, numerous open bedding planes; tripod drills employed, making holes 2½ in. in diameter and 16 ft. deep; spacing 6 to 10 ft.; "40 per cent" dynamite used; secondary blasting is by both "block-holing" and "mud-capping" methods, more explosive being used in secondary than in primary blasting; rock is hand-loaded; cars are hauled by mules.

Result.—Operating cost of delivering rock to crusher, 18 to 19 ct. per ton.

The use of more explosive for secondary than for primary blasting is due to the fact that the useful work done by the explosive in the primary shots is lessened by the presence of open seams, and also to the necessity of breaking the rock into small pieces suitable for hand loading.

Example 2: Conditions.—Crystalline limestone, overburden 6 to 15 ft. of clay or shale, many large clay pockets, rock variable in composition, churn-drill holes are 15 to 20 ft. deep and 6 in. in diameter, explosive used is "40 per cent" ammonia dynamite, electric detonators; secondary shots are mostly by block-holing method; rock is hand-loaded on four levels, locomotive transportation on heavy grades.

Result.—Operating cost of delivering rock to crusher, stripping included, is 32 ct. per ton.

Example 3: Conditions.—Quarry is situated in the Middle West; rock is an argillaceous limestone, fairly uniform in quality, with occasional seams and pockets; face is 40 to 60 ft. high, and is shot down as a single bench; churn drill employed, drilling holes 6 in. in diameter and averaging 55 ft. in depth, with a spacing of 10 ft. and a burden of 8 ft.; about 14 holes are shot at one time, "40 per cent" gelatin dynamite is used, about 150 lbs. in each hole; rock is loaded with steam shovels.

Result.—The total operating cost of drilling, including repairs, is 3.15 ct. per ton of rock. Assuming a price of 12 ct. a pound for the explosive, the cost of blasting per ton of rock is 5.76 ct. The total cost of drilling and blasting is, therefore, 8.91 ct. per ton of rock produced.

Example 4: Conditions.—Rock is hard limestone, with 3 to 8 ft. of soil overburden; churn drills are used, drilling holes 5⅝ in. diameter and averaging 70 ft. deep, main charges are 40 per cent "straight" nitroglycerin dynamite, with a little "60 per cent" dynamite in bottoms of holes; secondary blasting is mostly by "mud-capping" method; rock [illegible] capacity.

Result.—Cost of explosives (dynamite at 20 ct. per pound) is 7 ct. per ton of rock obtained; total operating cost of delivering rock to crusher is about 30 ct. per ton.

Example 5: Conditions.—Limestone, flat-lying, thin-bedded, 25-ft. face; blasts in churn-drill holes, in two rows and staggered, 8 ft. apart, "40 per cent" ammonia dynamite used, buffer method of blasting is employed; secondary blasting is by block-holing method; rock is loaded by steam shovel; locomotive haulage; average output about 1,500 tons per day.

Result.—Total operating cost of delivery to crusher, stripping not included, is 12 to 13 ct. per ton of rock obtained.

Production of Explosives In U. S. in 1917—The total production, excluding exports, of explosives in the United States during 1917, according to figures that the Bureau of Mines has received from manufacturers, was 582,475,327 lbs., as compared with 505,415,052 lbs. in 1916.

The Relation Between Civil and Military Engineers*

By MAJOR-GENERAL WM. M. BLACK
Chief of Engineers, U. S. Army

It would be interesting to know which is the older, military or civil engineering. When the first settlements of con[illegible] for [illegible] protection [illegible]. Certainly both branches of the profession developed [illegible] with the other, and they do so today. The fundamental principles of both are the same. The same mental training is required of both. Of the two military engineering is the more comprehensive, for there is not a branch of civil engineering which is not applied to military work, while to civil engineers in general the art [illegible].

The military engineers of to-day have organizations for the construction of ports; of port and interior terminals; for the construction and operation of railways, both broad and narrow gage, both in the territory far from the enemy's fire and directly in the field of bursting shells; for the erection and repair of locomotives and cars; for highway construction, for quarrying; for mining; for general construction of buildings of all kinds; for water supply and sanitary works; for chemical and physical research; for electric power and lighting; for surveying and mapping; for camouflage work; for gas and flame warfare; for the production of lumber from the forests; and in addition in each division there is an engineer regiment for military work at the front and in each corps are bridge and searchlight trains. I am speaking now of the Engineer organizations serving with the army in France, and being prepared for that service. To obtain the personnel for all of this would have been impossible had not the members of the engineering profession of the nation responded most nobly to their country's call. But further, there is not one of these Engineer Reserve Corps men who does not now know that he could serve his country to better advantage had he had, beforehand, military training—training much beyond that possible in a three months' camp.

Education of Civil and Military Engineer.—The fundamentals of the course of study required for a civil engineer of all branches of the profession are the same as those for the military engineer. The foundation of all is the general education which gives thorough command of our own language, both for speaking and for writing. An engineer not only must have ideas, but also must be able to express these ideas clearly to others. I have yet to discover any engineering project which cannot be described so as to be clearly understood by a non-technical man. Then, a knowledge of general history and of law is most valuable. Passing to the more technical studies, mathematics to and through the calculus, descriptive geometry, physics and mechanics, electrics, the principles of chemistry, some mineralogy and geology, and the qualities and nature of the materials of construction should be mastered before the special studies of any particular branch of the profession are entered upon.

In the examinations which have been held for some years of candidates for the position of Second Lieutenant in the Corps of Engineers of the Army, some interesting facts have developed. All candidates must be graduates from some approved technical school, and the questions to be answered in the written examination are such as should be answered by any man who has mastered his course. Yet the proportion passing these examinations is woefully small. At the last examination held, out of 190 candidates, the papers of only 36 could be accepted as up to or approaching the required standard.

The failures were not in the most difficult studies only—topographical surveying frequently was a stumbling block. Descriptive geometry was so generally unknown that the impression was created that the value of this subject was underestimated by the schools themselves. Yet what study does so much in teaching the mind to make a mental picture of the problem to be solved, and what quality is more valuable to any construction engineer than the ability to visualize a contemplated piece of work? Topographical surveying was found in cases to be not thoroughly understood, yet in what branch of the profession is ability to interpret topographical maps not necessary?

It has seemed at times as if the whole scheme of the education had been at fault, that the scholars had never been compelled to tackle the tasks set and do the allotted work as a duty, whether congenial or not, and further, that the foundation of all, the general knowledge that every man who wants to attain success must have, was lacking.

Is it not better to have the mind so trained that it can grapple unafraid with any problem, than to start life with only a smattering knowledge of certain applications of partially understood laws? The courses of study at the schools are for two distinct purposes, one to train the mind and the will for work, and the other to furnish the useful tools for doing the work. The memorizing of certain facts is of little value. The ability to do certain things in a certain way without knowing clearly why that way is best, or even if it be the best, is poor preparation for an engineer. The study of accomplished engineering work has the same value as the study of history. It is experience acquired at second hand, but to be most valuable, failures should be studied along with successes. The development of mankind as portrayed in general history is a picture of a struggle upward with many slips and falls, but nevertheless with a continued advance.

Fundamental Principles Remain Same But Methods of Application Change.—It is a saying well known to students of military affairs that strategy is always the same but tactics vary. In other words, the fundamental principles of the science of war always remain the same, but the methods of applying these principles vary through the ages in measure as the advancing knowledge of nature's laws forges new tools for the soldier's use. The better knowledge of chemistry and of metallurgy are the main causes which make the fighting methods of this war different from those of earlier wars. Have you ever thought of a ship as a truss, which must have a certain limitation of depth on account of the natural limitations of our harbor entrances but whose length (and consequently the cross section of the ship) is limited by the qualities of the materials which are available.

So with our guns. Increased chemical knowledge gives new and more powerful explosives. Advances in metallurgy make it possible for these explosives to be utilized to the greatest advantage. Improvements in the vehicles of transportation, in the paths in which they travel and in the means for the transmission of orders, make possible the handling of men in larger bodies and on larger battle fronts. In all lines of endeavor required by war, the influence of the advancement of human knowledge makes itself felt, and those charged with the responsibility of defending the nation's life must be constantly alert to take advantage to the fullest extent of the advancements in human knowledge.

In military engineering, the officer entrusted with certain work must obtain beforehand all the information he can. He must study the surroundings, take into full account the character of the tools and supplies available, and must know the number of men whom he has to carry out the work, as well as their individual abilities. He must then lay out the plan he hopes to follow, estimate probable difficulties to be met, and be ready to change this plan at short notice and adapt it to unexpected happenings. All this means that he must be thoroughly trained in the art and craft of his profession, so that when trouble occurs his mind will work in part intuitively and he can see quickly the best course to take and will be prepared to follow it and carry it through. All this involves a long and special training and a quickness of view and decision which are vital to the success of his work, especially in war.

The same principle holds good in civil engineering, in which the general principles of mechanics and construction remain unchanged, but the processes must vary with the character of work to be done, with the condition of the labor market, with advances in machinery and methods of doing work, etc. This is exemplified particularly in those works in which the great forces of nature must be opposed, or made obedient servants for the accomplishment of a desired result, as in river and harbor improvements. The chief enemies are the weather, storms and floods, and often an uncertain supply of labor and a long distance from a base of supplies.

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*From "Professional Memoirs."

While the civil engineer does not often have to make the instant decisions of the military engineer engaged in actual war, he must, nevertheless, follow the same path in carefully planning his work ahead, must see that one part in the programme will not delay or overlap another, and must have behind him a general knowledge of construction and an experience in the special work he has in view which will enable him to meet and decide the unexpected and drive the work ahead.

In both cases—the civil and the military—the chief requisite to success is the careful study and choice of a suitable plan of work and the ability to meet the changes in conditions which always come.

Problems in Military and Civil Engineering Similar.—Again, the problems connected with the organization, care, training and use of large bodies of men are similar in both military and civil engineering work. The greater the hazard, the greater the need for discipline. The larger the force, the more elaborate must be its organization. The more active the opposing forces, the greater the need for the training which makes the doing of the necessary thing intuitive. Discipline is probably the most essential factor for efficiency where large bodies of men must act in coordination in a hazardous work. The will of each man must be subordinate to that of his commander. What may be the right thing to do from the viewpoint of the subordinate might be disastrous from the broader vision possible to the commander. This subordination of will must be sharply distinguished from the blind doing of what is directed. Intelligent initiative must always be cultivated, for each man is allotted a definite field of responsibility, and within that field he must be prepared to act promptly and intelligently.

Before a man can consider himself a real soldier he must have acquired a self-mastery which will make him intuitively ready to obey loyally and at the same time to command effectively. This comes only after long and hard training. Donning a uniform, with or without shoulder straps, and knowing something of military drill does not make a soldier. Soldierly qualities may be cultivated in ordinary school life—with or without strictly military drills.

Through the ages there has developed in all nations a system of training and of customs designed to aid in the installation and cultivation of discipline. The courtesies demanded between soldiers is one of these aids. Military courtesies in final analysis prove to be the same as those that should prevail in civil life between the young and the old, between the young man starting in life and the man who has already achieved distinction in his fulfillment of life's duties. In civil life, unfortunately, these courtesies are too frequently neglected. In Military life they are enforced. In the army rank is assumed to be the mark of distinction, and the junior pays deference to the rank of the senior. The obligation of courtesy is the same for each, but the salute must be made first by the junior.

An army constitutes the largest force assembled by man for the accomplishment of a single purpose, and the accomplishment of that purpose involves hazards greater than those of any other human endeavor. Hence, in an army discipline, organization and training must be carried to the highest degree. With the great number of men gathered together for a single work come increased problems of supply and care. The sanitation must be supplied as needed and in sufficient quantity. To supplies of this character must be added supplies in enormous quantity of all the kinds and varieties required for the comfort and protection of the men and for the needs of offensive and defensive operations. This supply of an army requires great system in the methods of obtaining, using and replacement.

This subject is too much neglected by men who aspire to commissions in the army. A large part of the suffering among newly organized troops is due to the ignorance of their officers of the methods of supply; another large part to a lack of discipline. So I say to those of you who desire to enter the service as officers of any branch, learn discipline first and the care of men next. The technical details of work are easy to learn. In a lesser degree the same advice is good for those of you who expect to practice your profession in civil life only.

The construction methods used in works of military engineering and in works of civil engineering are much the same. In the military work at the front any materials at hand must be utilized.

Economy must be disregarded. Economy in time is the essential. Initiative and fertility in resource in the engineer in charge and discipline and training in the men are the elements of success. Tools are provided in the engineer train. Materials in general must be found. In river crossings the bridge trains are used first for ferrying, then in a bridge. Immediately, however, a fixed bridge must be started with the best materials which can be found and of the type best suited to the conditions at the site. Here again the engineer in command must be able to form instantly an accurate judgment and must be able to make his plans for the work without any office assistance and generally without even drawings. His bridge must have stability and sufficient strength to carry the heaviest loads which the material of the army demands, including armored tanks and ten-inch guns.

Blasting Limestone Boulders

A combination of snake holing and mudcapping is employed by an Iowa blaster for breaking isolated limestone boulders in land clearing. His first operation is to dig a hole down alongside of the boulder. This hole goes down as deep as the boulder is imbedded in the ground. Then with a pointed steel bar he drives a hole close up under the stone, making it a point to get the end of the hole as nearly under the center of the boulder as he possibly can. In this hole the charge of dynamite is loaded. If it is a small stone the charge is loaded in a ½-in. bore hole. If it is a large one the end of the hole is enlarged so that it will accommodate a charge of the size required to turn the stone out of its bed. A 35 per cent ammonia dynamite is used for this first operation. Frequently this charge under the rock, which should be well tamped in, will break it into two or more pieces. In fact the one charge sometimes is sufficient in itself. However, the main object in making this first shot is not to break the stone, but to turn it out of the ground. After getting it out on the surface, the most vulnerable point of the stone is selected; a little cavity is desirable. At that point is placed the mud-cap charge. A fast, shattering dynamite 60 per cent straight is needed for this work. The cartridge paper is removed and the dynamite crumbled and placed in a compact mass in the cavity or depression. The amount of dynamite needed to break a rock, of course, depends upon its size. The cartridge paper is then laid over the little heap of dynamite and the charge is then covered with a thick cap of wet earth. A heavy plastic clay makes the best mud-cap, if it is obtainable. Of course, a cap and fuse are imbedded in the pile of dynamite before the mud cap is placed over it.

Comparative Costs of Track Construction in Paved Streets.—H. L. Mack, Superintendent Track and Line International Ry. Co., Buffalo, N. Y., in the December Aera gives the following figures showing the cost of street railway track construction in paved streets:

Year.	Single track. Per mile.
1895	$26,000
1900	28,600
1905	28,600
1910	36,750
1915	40,340

The above costs include track and pavement complete. Mr. Mack states that the increase in cost from 1895 to 1915 was due wholly to the heavier and more substantial type of construction made necessary on account of the public demands for larger cars and equipment necessarily of heavier type.

Requirements for Creosoted Fir in Marine Construction

[illegible]

The Piling or Lumber Must Be Well Seasoned Before Impregnation with Creosote.—If the material is not well [illegible] material through which marine borers and ship-worms may enter. Water-stored piling has a strong tendency to become case-hardened and excessively dry on the surface exposed to the sun, while the under side remains waterlogged. When such material is creosoted by the boiling process, the [illegible] will be very heavy, while the other side will receive very little. This is due to the difficulty of seasoning such material to a uniform moisture content. To remedy this condition it has been proposed to first impregnate the pile with creosote before attempting to dry it, thus securing a satisfactory penetration on the side that it already sufficiently dry, and then boiling until the wet side is dry enough to take the oil, when pressure is again applied to the oil, thus securing a satisfactory penetration in this side also.

The Material That Is Creosoted Must Not Contain Large Knots.—Creosote does not readily penetrate the harder wood of knots, hence large knots are very likely to offer untreated spots where ship-worms may enter. Small knots are not so serious, as such knots are more readily impregnated with creosote. A recent large purchaser of creosoted piling in Seattle has attempted to overcome the bad effect of the knots by boring ⅜-in. holes about 2 in. deep in all knots over 1½ in. in diameter before the piles are creosoted. The holes are plugged with dry fir plugs secured with galvanized iron nails. The presence of the holes causes the knots to dry out readily so that a heavy local penetration can be secured in what would otherwise be the weakest points in the pile. The scheme has merit and will [illegible] be much used in the future.

The Protective Layer of Creosoted Wood in the Piling or Lumber Must Not Be Broken.—Axe chops in creosoted piling make extensive attacks of marine borers inevitable, rendering the creosoting useless. Ship-worms can also enter through the holes left by nails, dogs, bruises and other avoidable injuries which result from carelessness in the handling of creosoted material after treatment. Creosoted material must not be framed after treatment. Such stupidity will absolutely nullify the protective effect of the creosoting.

Untreated Material Must Not Be Placed in Contact with Creosoted Material.—Uncreosoted sway braces or waling must never be used in connection with creosoted piling or timbers that are used in marine construction, for ship-worms in many cases may obtain foothold in the untreated material and penetrate the creosoted material after they are fully developed, when creosote is no longer an effective barrier. Creosote is absolutely effective in keeping out the larvae, which are most delicately organized.

The Total Amount of Creosote in Piling or Lumber Used for Marine Construction Is of Less Importance than the Depth of Penetration of the Creosote.—Ship-worms are not mathematicians. The fact that a pile may contain an average of 12 lb. of creosote per cubic foot means nothing to the simple mind of the "teredo." If untreated spots exist in the surface of the pile, ship-worms will destroy the pile regardless of the total amount of creosote that has been used. The important requisite is therefore that the penetration of the creosote must be uniform. It follows, then, that the material that is to be creosoted must be free from large knots and that it must be dry when creosoted.

Creosoted Piling Should Never Be Over-driven.—The driving should cease when the pile no longer penetrates readily, as over-driving may produce longitudinal splits through which ship-worms will quickly enter.

Creosoted Lumber and Piling in Docks Should Be Protected with Boom Sticks. Floating driftwood [illegible] docks [illegible] the surface of the piling and break the protective layer of creosoted wood. To keep the driftwood out, boom sticks should be placed just inside of the first row of piles around the dock, chained in such a manner that the sticks will not float against the piling on [illegible].

The Untreated End of the Pile Left by the "Cut Off" Should Be Protected from Decay.—Well-creosoted piles will quickly fail through decay unless this is done. The usual practice is to paint the freshly sawn end with one coat of hot coal tar creosote. This is not sufficient, but should be followed by one liberal coat of cold creosote as soon as the first coat has been absorbed. In the opinion of the writer, it would be a good practice to first give the end of the pile a good soaking with a hot 1 per cent solution of bi-chloride of mercury in water, and after it has dried somewhat to follow this with the two coats of cold creosote.

Present specifications for piling are usually too severe in one particular, and that is the degree of straightness that is required. In driving, the piles are stressed to a much higher degree under the impact loading of the pile driver hammer than they will ever be subjected to in the completed dock where only low static loads are permitted. If the piling is not too crooked to be placed in the gins of the pile driver and will stand up under the driving, it is perfectly serviceable regardless of the crook and should be used. A crooked pile free from knots is immensely much more serviceable than a knotty pile that is straight as an arrow. The present specifications that demand perfectly straight piles accomplish no useful object and increase the cost of the material unnecessarily. This increase in cost, of course, falls upon the purchaser who buys piling under such specifications.

Troop Movements by American Railways.—From Jan. 1, 1918, to the armistice the railways of this country moved a total of 6,496,150 men, an average of 625,434 per month. The maximum was reached in July, when 1,147,013 men were moved. In all 1,785,342 drafted men were picked up at 4,500 separate points in larger or smaller units and moved on schedule to their training camps, in many cases upward of a day's journey, and in all cases were fed in transit. The amount of detail involved in routing, scheduling, moving, and feeding these men can hardly be over-estimated. A total of 4,038,918 in 9,109 special trains were moved an average distance of 855 miles, unquestionably the largest long distance troop movement in history. A total of 1,904,014 were brought into the crowded port terminals for embarkation overseas without interference with the heavy traffic of other kinds already being handled through these ports and in the territory adjacent thereto. During one period of 30 days more than 20 troop trains each day were brought into the port of New York. During the period there were but 14 train accidents involving either death or injury of enlisted men. In these accidents 14 men were killed and 306 were injured. The special troop trains averaged 12.2 cars per train and traveled an average distance of 8,546 miles. The average number of hours per train was 42.6, the average speed was 20 miles per hour, and the average number of men per train was 443.4.

$5,350,000 to be Spent This Year on Chicago Union Station. [illegible] for work on the new Union station at Chicago are understood to provide for an expenditure of $5,350,000 in 1919. The program includes the following:

Depression of tracks to ordinance grade between Van Buren and Twelfth St. Rearrangement of tracks to permit construction of viaduct foundations. Construction of:

Harrison street viaduct.
East half of Burlington freight house.
Polk St. viaduct.
Canal St. viaduct between Polk and Taylor.
Taylor St. viaduct.
Canal St. viaduct between Harrison and Polk.
Filled elevated on Canal St. between Taylor and Twelfth.
West half of Burlington freight house.
South half of Twelfth St. viaduct.

Right of Way Ditching With Electrically Operated Ditcher

By employing an electrically-operated ditcher the Kansas City, Clay County & St. Joseph Ry., a 78-mile electric railway, has effected a marked reduction in the cost of right of way ditching. The machine—an American railroad ditcher—was placed in operation in 1915 and has handled during the working season, May to December inclusive, an average of 200 cu. yd. per day. The ditcher has a 20 H. P. motor and operates on 1,200 to 1,500 volts. It was the first electrically operated machine of this type to be built. The ditcher is mounted on a specially constructed flat car 50 ft. long and with a capacity of 100,000 lb. The ditcher travels back and forth on the car on two sections of 100-lb. A. S. C. E. rails, this being necessary in order to permit the flexibility of forward or backward motion when loading the shovel or, if the material is to be hauled, when unloading into dump cars placed in front of the ditcher. Information on the operation the ditcher is given by Mr. Charles W. Ford, General Superintendent of the K. C., C. C. & St. J. Ry., in the Electric Railway Journal from which the matter in this article is taken. A great amount of the material that is necessary to handle out of the ditches is a grade of clay which is exceedingly difficult to dig when dry, and is about the stickiest substance extant when wet. Rock and shale are encountered in the cuts along the line and a [illegible] slides were not uncommon in wet weather. In most instances the material taken from the ditches and the cuts is deposited on fills, but in shallow cuts the material taken from the ditches is in many cases deposited on the surface of the sides of the cut, thus providing an embankment which takes the place of surface ditches. This operation, which is much more rapid than is the use of dump cars, eliminates the haul entirely. The dump cars are of the side-dump type, holding 20 cu. yd. and are operated by air, the entire train being hauled by an electric locomotive as shown in Fig. 1.

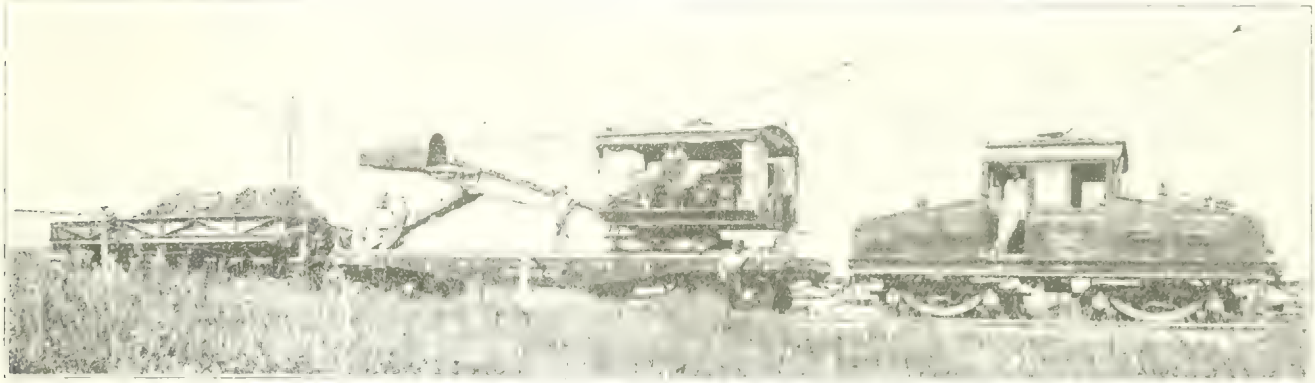


Fig. 1—Electrically Operated Ditching Outfit on K. C., C. C. & St. J. Railway

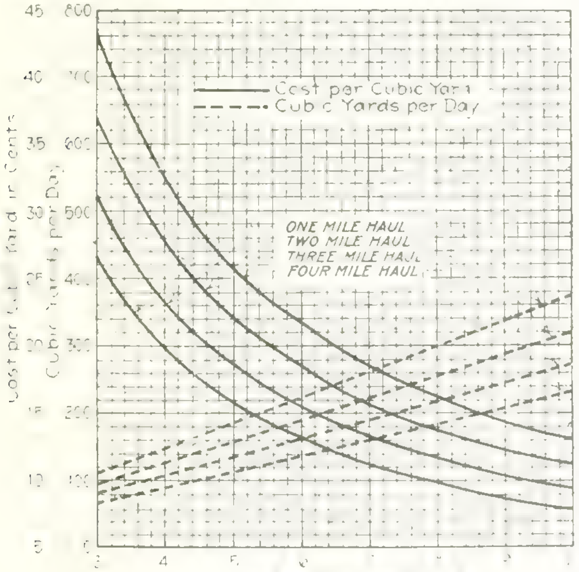


Fig. 2—Cost Graph for Electric Ditcher.

During 1918 it was necessary to use the ditcher for a period of only two months, and for the 60 days from May 1 to July 1, 1918, the following figures covering an average day's work have been compiled:

Work: Right-of-way ditching, cut widening and bank filling.
Material: Clay, hard dry and tough, with some stone and shale.
Length of day: Fourteen hours.
Time actually working: Seven and one-half hours. (This includes the time consumed in ditching, dumping and traveling to and from the siding, clearing for trains.)
Crew used: Operator and two laborers. Train crew: Motorman and conductor.

Daily Cost:

Payroll	$23.52
Power	5.07
Oil, waste and repair	2.70
Incidentals	1.26
Total	$32.55
Average daily yardage, cu. yd.	227.6
Cost per yard, ct.	14.3

Besides being used for the above-mentioned work the ditcher has frequently been used as a pile driver by the simple attachment of a pair of leads, and it is also used in place of a crane or derrick for unloading ties, rails and machinery.

Cost Accounting System for Sand and Gravel Producers

A uniform cost accounting system has been adopted by the Chicago Association of Sand and Gravel Producers. Under this system the factors entering cost are grouped under three main expense accounts: General expense, selling expense, and production expense. The distribution in these three accounts is as follows:

GENERAL EXPENSE.

1 Salaries of officers and office employes.
2 Office expenses, including stationery, printing, telephone, postage and office supplies.
3 General expense, including legal expense, membership in associations, subscriptions to papers.
4 Bad accounts. All uncollectable accounts charged off during the current year.
5 Taxes, including income and war taxes.
6 Interest on investment—Invested capital at 6 per cent.
7 Depreciation—Includes office fixtures, automobiles, buildings, machinery and personal property.

SELLING EXPENSE.

1 Salaries of Salesmen.
2 Expenses of salesmen, including traveling and incidentals.
3 Advertising—General publicity, direct advertising and incidental expense.

PRODUCTION EXPENSE.

1 [illegible] except for those employed in stripping.
2 [illegible]
3 [illegible]
4 Repairs. Including new parts to replace others worn out or broken, with freight or express charges on same.
5 Depletion of land or royalty.
6 [illegible]
7 [illegible] ex- [illegible]

The system was prepared by a committee consisting of B. H. Atwood, E. J. Roche and F. E. Lane.

Power Plants for Gold Dredging Installations in Isolated Districts

[illegible] in cold [illegible] highly in- [illegible] it is the [illegible] but often electricity is either not available or can be developed only [illegible] dredge. [illegible] in power [illegible] company is building a number of dredges or if several companies con- [illegible] central power plant to generate electricity will as a rule prove economical. Should electric power be neither available nor feasible then some other form of power must be considered. An interesting discussion of this subject is given by Mr. Charles Janin in a Bulletin, "Gold Dredging in the United States," [illegible] by the U. S. Bureau of Mines. The following notes are abstracted from the bulletin:

The first steam dredges were excessive consumers of fuel, and operating costs were high in comparison to those when electricity became available for use on the same dredge. An example of the reduction in the power cost in dredges is that shown on the operation at Ruby, Mont. With the cost of coal at $4.90 a ton the fuel costs of the [illegible] steam dredges during 1904 to [illegible] cubic yard. Although these were old-type and inefficient machines, the figures cited illustrate the high power cost under steam operation even with a low fuel cost. The cost of power and fuel for the present Ruby dredges averages less than 1½ ct. a cubic yard.

Practically all dredges now operating in the United States use electricity. In Alaska where the single-dredge installation is the rule and on the Seward peninsula where upward of 100 dredges have been built, 40 of which were either operating or under construction in 1913, only two used electricity. In this field and in the Philippines the American dredge constructor has had the opportunity to exercise his ingenuity and here most experiments have been made and the greatest development has taken place in the power arrangement of the self-contained dredge.

Since the table above was made, in 1912, there have been a number of changes made on these dredges, and two have shut down. The results indicated, although representative of work at the time specified, cannot be considered as representative of the best present-day practice. It must also be noted that the fuel costs do not include labor, etc.

The use of gas engines demonstrated that a great saving could be made in the cost of fuel on dredges using coal, wood or crude oil when transportation of such fuel from the seaport was necessary, and continued experimentation demonstrated that still further saving could be made by improved methods.

Example of Fuel Saving by Redesigning Power Plant.—[illegible] example of reduction of fuel costs is furnished by the operation of the Three Friends or Seward dredge. This dredge was built in 1908, and for reasons satisfactory to those interested in the company, was equipped with slide-valve engines and locomotive boilers. The coal consumption varied from 12 to 17 tons a day and the cost of coal delivered to the dredge was $22 a ton; with 14 tons at $22 as the average consumption, the fuel cost was $308 a day. The average daily capacity of the dredge was 2,000 cu. yd., so that the fuel cost was 15.4 ct. a cubic yard. In the latter part of 1912 oil burners were installed on the dredge and fuel oil costing about $3 a barrel was used as fuel. This change, although reducing the fuel cost somewhat, did not give the results the management anticipated, some days as high as 60 bbl. of oil being consumed. It was not until 1914 that any radical change was attempted. The entire plant was redesigned. Semi-Diesel engines were used to generate electric power at a shore plant and electric motors were used on the dredge. The old machinery was consigned to the rock pile.

Figures of operating cost of the new plant, furnished by the management, are as followes:

OPERATING COST OF THREE FRIENDS DREDGE FOR 24 HOURS, 1914

[illegible] at power plant	$36.00
[illegible]	21.00
[illegible]	15.00
[illegible]	24.00
[illegible]	10.00
[illegible]	15.00
[illegible]	[illegible]
[illegible]	6.00
[illegible]	22.00
[illegible]	7.50
[illegible]	15.00
Total	$179.00

A point that was not at first realized in changing the power equipment on this dredge was the decrease in weight resulting from replacing the cumbersome inefficient steam plant with electric motors. The change permitted the dredge to work without digging so deeply into bedrock, thus permitting a greatly increased yardage. The yardage handled by the dredge has been variously estimated at 2,000 to 3,000 cu. yd. a day, making an operating cost for fuel used of approximately 1½ to 2 ct. a yard.

Power Cost on Two Dredges on Seward Peninsula.—Two dredges recently constructed on the Seward Peninsula and equipped with entirely different power arrangements are of considerable interest in showing a great reduction in power as compared to dredges having self-contained power plants using similar fuel in the northern field, and the operation of these dredges should be carefully studied by anyone contemplating dredge operation. The Berry dredge was equipped with two 75-HP. Wolf locomobile engines using wood for fuel. The following figures were obtained from the operating report of Gerald Hutton, dredge superintendent for the company:

DATA COVERING OPERATION OF BERRY DREDGE ON THE SEWARD PENINSULA, ALASKA

(Operating days, June 3 to Oct. 17, closed down for winter and for thawing ground.)

Net operating time (131 days, 100 per cent), hours		3,144
Total lost time (25.7 per cent), hours		805
Total digging time (74.3 per cent), hours		2,339
Total depth dug, feet		11.9
Total yardage handled, cubic yards		213,357
Total yardage handled per day, cubic yards		1,628
Total wood used, cords		464.35
Total cost of wood used, 464.35 cords, at $10	$4,643.50	
Cost of getting to dredge	594.37	
Wastage, estimated	261.89	
		$5,499.75
Total cost of wood per cubic yard, cents		2.57
Total operating cost per cubic yard, cents		11.23

The lubricants used throughout the season were as follows:

LUBRICANTS USED BY BERRY DREDGE DURING OPERATING SEASON

Lubricant	Total quantity used	Per day	Cost for season *
	Gallons.	Gallons.	
Hecla B. cylinder oil	84	0.64	$ 92.40
Atlantic red oil	237	1.8	111.00
	Pounds.	Pounds.	
Arctic cup grease	400 }	3.8	{ 44.00
Dixon special grease	100 }		{ 16.55
Mica gear grease	556	[illegible]	30.26
Total expense for the season	...	....	$324.21
Total lubricating cost per day	...	....	2.47
Total cost of lubricating engines per day	...	...	1.78

*Including freight and hauling. The consumption of lubricating oil on the engines will be reduced the coming season, as the oil filter was not received until fairly late in the season under consideration.

The engines gave minimum trouble, but experience gained

TABLE I.

Name of Dredge.	Size of buckets, cu. ft.	Average daily capacity, cu. yd.	Horse-power of dredge.	Fuel used each day.	Quantity.	Cost of fuel per unit.	Approximate cost of fuel per cubic yard.	Operating conditions.
[illegible]	[illegible]	[illegible]	[illegible]	Coal	7 tons	$27.00	10.5	Average
[illegible]	[illegible]	[illegible]	[illegible]	Coal	12 to 17 tons	22.00	15.4	Difficult
[illegible]	[illegible]	[illegible]	[illegible]	Distillate	300 gallons	0.25	4.2	Average
[illegible]	[illegible]	[illegible]	[illegible]	Crude oil	14 barrels	3.00	5.2	Some frozen ground
[illegible]	[illegible]	[illegible]	[illegible]	Wood	7 to 12 cords	12.75	12.7	Average

in their use showed the advisability of having on hand certain duplicate parts in order to obviate long delay from any breakage that might occur. The time lost by the digging engine was 4 hours 20 minutes, being lost principally through inspection of the different parts. The time lost by the pump engine was 18 hours 55 minutes.

The key holding the hoisting-pump crosshead to the piston rod sheared and was replaced by a tool-steel key, which gave no further trouble. The babbitt bearing of the hoisting-pump became hot and melted, probably on account of failure of the oil feed. The brasses were replaced by spare brasses at a small expense.

Although the power cost on this dredge is high as compared to the cost of power on a dredge working in the United States and using electrical current costing from ¾ to 1½ ct. for each cubic yard produced, the power cost per cubic yard is a remarkable showing for a self-contained dredge in the northern fields, and may reasonably be compared with the stated cost of the Three Friends dredge, as the figures given for that dredge are to be considered estimates only.

The Bangor Creek dredge operating near Nome is also equipped with 3½ cu. ft. buckets. Power is supplied by two semi-Diesel Bolinder engines with a total of 140 HP. Oil fuel is used, a mixture of 4 parts 16° crude and 1 part 48° distillate. It is stated that the average consumption of this oil is 180 gal. a day, and the average daily yardage handled over a depth of 30 ft. is 1,500 cu. yd.

The successful work of recent American dredges in the Philippine Islands has greatly stimulated the dredging industry in that field. The Guamos dredge uses wood for fuel. During 1913, according to the annual report of the operating company, the dredge was in actual operation for 5,731 hours and handled 814,500 cu. yd. of material. During this period 4,500 cords of wood was consumed, costing $5 per cord delivered on the dredge. The fuel cost per cubic yard thus indicated is 1.38 ct., an encouraging figure considering the conditions under which the dredge works.

Novel Power Plant of Philippine Dredge.—A radical innovation was the motive power designed for the Mambuloa dredge in Ambos Camarines in the Philippines. A steam turbo-generation was placed on the dredge to provide the electric current, being the first instance of such a plant being used for gold dredging. Although no reports of operation are yet available, this type of power plant has been successfully used on the United States collier Jupiter. The dredge plant consists of a 300-HP. wood-burning boiler with condenser and a 625-kilowatt-ampere (500 kilowatts at 80 per cent power factor) turbo-generator running at 3,600 revolutions per minute, 440-volt, alternating-current, 3-phase, 60-cycle, with direct connected exciter. The main drive motor is 150 HP. with reversible speed controller, which will reduce full speed one-third. The other motors are as follows:

DATA ON MAMBULOA DREDGE

	Horsepower.
Main winch	[illegible]
High-pressure pump	[illegible]
Low pressure pump	[illegible]
Screen drive	[illegible]
Stacker	[illegible]

In addition to the main power plant there is an auxiliary steam engine of 20 HP. which can operate the winch and move the dredge in case of accident to the turbo generator, during the storm or other emergency. This engine is used for lighting the dredge when the main plant is shut down, and can also be used to take the place of the exciter in the generator should that get out of order.

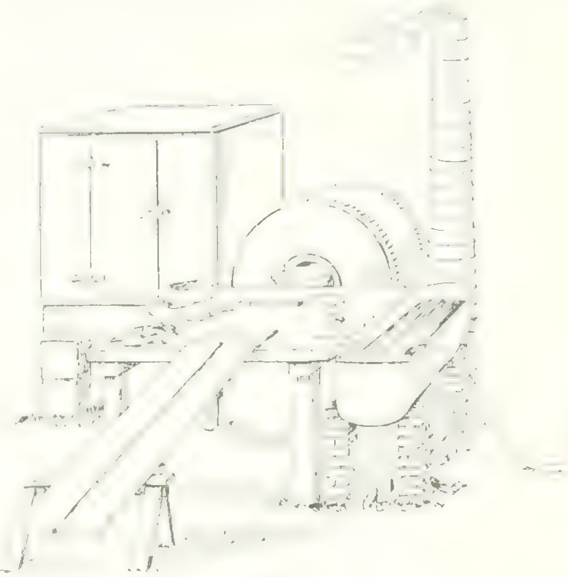
Of interest in connection with this dredge is the fact that the water for the boilers comes through a special pipe line from a fresh-water spring in the hills. This plan was adopted to obviate the possibility of damage from salt water in the river, which caused serious boiler trouble on one of the dredges in the Paracale district.

A dredge of this type is expensive in first cost, as the plant includes not only an electrically-driven dredge, but also a separate power-plant built on the dredge instead of the usual plant on shore. It is asserted by the makers that the operating cost is less under these conditions than with a separate plant on shore, as all operations are under the direct supervision of the dredgemaster, and only the one working crew is necessary. Should a second dredge be built, as is contemplated if results are in keeping with expectations, the power plant may be moved from the dredge and suitably rearranged on shore for two dredges. The dredge has been designed with this possibility in view, and for this reason a 625-kilovoltampere generator, which is in excess of present requirements, is placed on the dredge. Seemingly another boiler is to be added to the shore plant if that is later constructed. Although no figures of operation are yet available, details will be awaited with interest on account of the new features involved.

Suction gas engines have been tried in some dredging operations in the Federated Malay States, but such figures of actual results as are obtainable would indicate that this type of power as applied has not proved a decided success.

Arrangement for Heating Water for Winter Concreting

The arrangement shown in the sketch was used during the winter of 1916-1917 by the Raymond Concrete Piling Co. on its contract for placing concrete piles and footings for the foundation of the Breakers Hotel at Chicago. This job was located on the shore of Lake Michigan. The temperature often dropped as low as 4° below zero and the winds which swept from the lake made the working conditions very adverse for concrete work.



Cold Weather Concreting Outfit.

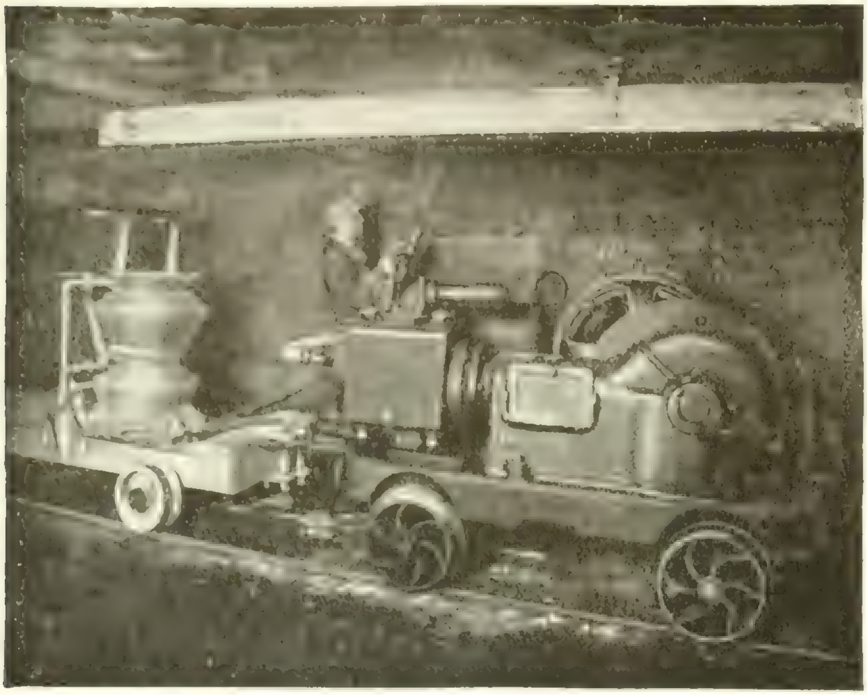
The equipment shown was the standard plant used in warm weather, with the exception of the second hand bath tub which was purchased at a cost of $3.50. The runways made of 2 in. x 10 in. x 16 ft. planks; the concrete mixer; the 6 ft. x 6 ft. x 3 in. platform; the Raymond shell used for a smoke stack are a part of the regular concreting plant. The bath tub was blocked up with brick found on the job and placed next to the concrete mixer with the top level with the platform. The water in the bath tub was heated by burning old railroad ties. The frost and ice were removed from the sand and gravel by placing the piles of material on top of iron pipes 18 in. in diameter in which fires were made, using railroad ties for fuel.

One laborer was detailed to work on the platform, feeding the cement and warm water to the concrete mixer. A pail was used for conveying the water from the bath tub to the mixer. The water in the tub was maintained at the correct temperature by the addition of cold water, which was supplied by a ¾ in. rubber hose.

The additional cost for this winter concrete work over ordinary summer work was only 25 ct. per cubic yard for the concrete placed, states The Contractors' Atlas, to which we are indebted for this article. This cost includes the cost of the railroad ties delivered on the job and the additional labor required for maintaining the fires and handling the materials.

Method and Cost of Coating Mine Roofs and Ribs by Cement Gun Process

Excellent results have been obtained by the United Coal Corporation of Pittsburgh, Pa., from coating roofs and ribs in the [illegible] coal mine by the cement gun process. These results, states Mr. M. S. Sloman, in an article in Mine & Quarry, to which we are indebted for the following matter, seem to prove conclusively that a cement coat [illegible] [illegible] applied will form a permanent barrier to the action of weathering on roofs susceptible to air slacking.



Cement Coated Roofs and Ribs in Main Slope at United Coal Co.'s Edna No. 1 Mine

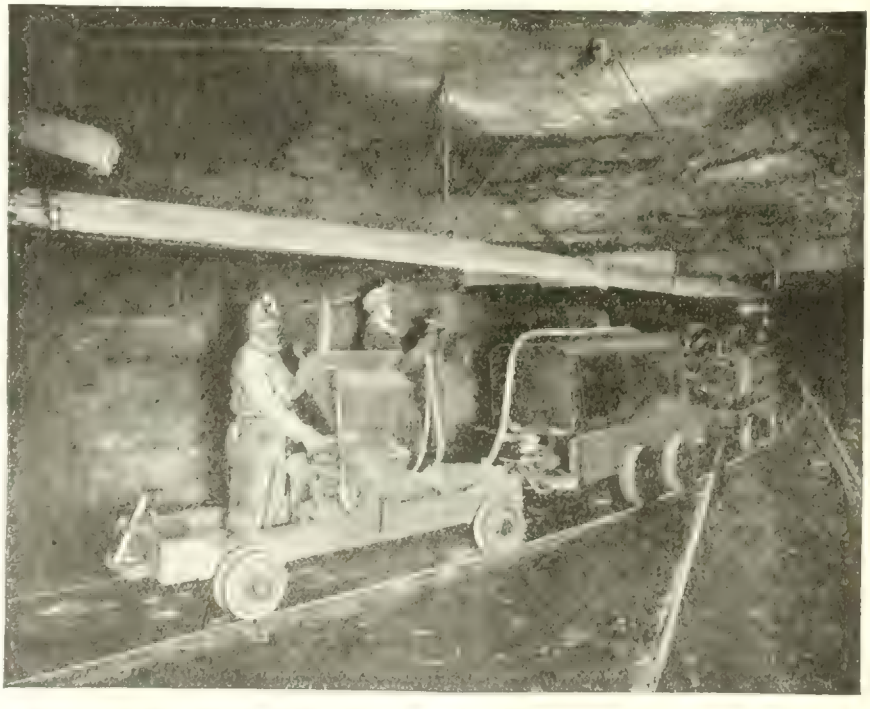
The work has been carried on at the Edna No. 1 mine, located at Adamsburg, Westmoreland County, Pa., near Pittsburgh, where the company is working the Pittsburgh seam, averaging 6 ft. in thickness, with the characteristic roof coal of about 12 in. and above that a slate and clay composition containing limestone which is readily disintegrated by contact with air. Without question this cement gun coating was applied under the most adverse conditions that could be found. The coal is taken from the mine through a main slope, first started some 18 years ago, and driven in 6,500 ft. Trouble has been encountered from the start due to falls from roof, as evidenced by the average distance from the coal to the roof, which is about 12 ft.—frequently the road was completely blocked by such falls, necessitating the closing of the mine on an average of three or four days every summer. Owing to the risk involved, no man-trip could be run and the miners were obliged to walk in and out from work. It was on this slope where the work was started on Nov. 1, 1917.

Equipment. The equipment consisted of an "N-1" cement gun, manufactured by the Cement Gun Co., Inc., [illegible] [illegible] essentially it consists of a hopper with control valves for mixing the material and a nozzle at the end of a hose, where the dry sand and cement conducted under air pressure, is mixed with water and directed at high velocity on to the surface to be coated. This apparatus is mounted on wheels of suitable track gage making it entirely portable

In this mine, as in many others electrically equipped, there is no supply of compressed air available To meet demands of this nature, the Sullivan electrically operated portable air compressor was developed. This can be conveniently taken into the mine to the location of the work. It consists of a single stage compressor driven by a motor through gearing, all mounted with an air receiver on a substantial base which in turn, with addition of wheels and axles, forms a truck.

Since there was no supply of water under pressure available for this use at the Edna mine, an ingenious system was used. A large tank, of size to hold sufficient water for a shift, was mounted on a mine car; a connection was made with the air receiver and this water, brought under air pressure,' was forced up to the spraying nozzle.

Method of Applying the "Gunite"—The work is done at night by a crew consisting of from 5 to 8 men. One man operates the gun, one the compressor, and serves as general mechanic; two others mix the material and one operates the nozzle. In addition, the following men are employed outside for part of their time: One hauls material, one dries sand and one handles the hoisting rope when working on the grades. It was found that the mixing could best be done outside the hopper, so wooden boxes are used for that purpose and the mix dumped into the hopper. The mix consists of three parts fine sand (and this must be thoroughly dry) to one part Portland cement. The air pressure for the most effective work should be from 40 to 60 lb., while the water should be under a pressure of about 20 lb., higher if possible.



Cement Gun, Water Tank and Air Compressor Outfit.

The surface to be coated is first thoroughly cleaned and scaled, which is most essential. It is the opinion of Mr. Maize, the local superintendent, that where possible, the use of a stream of water would prove very effective. No wire or reinforcement of any kind is used in coating the bare roof and side walls, and the coating is applied direct, averaging ½ in. in thickness.

Pieces of coating afterward broken off show a perfect bond existing between the cement and the substance composing the surface, whether it be coal or rock. In coating the timbers, a ½-in. wire mesh is first stretched and secured to the surface before the cement is applied.

An accurate record of progress and costs has been kept from the start. The total cost of coating 6,250 ft. of slope, averaging 12 ft. in width and 12 ft. in height on sides has been $7,488.58. This figures a net cost of 30 ct. per square yard.

The following figures taken at random show detailed costs on a length of 900 ft. of slope which was completed in 13½ shifts of 8 hours each:

1 mechanic	[illegible]
1 engineer for rope hoist	[illegible]
1 operator Cement Gun	71.85
2 mixers at $6[illegible]	[illegible]
1 man at nozzle	[illegible]
1 man drying sand	61.40
1 man haul material part time	23.50
540 sacks cement at 60 cents	324.00
1,620 sacks sand at 12 cents	194.40
Total	$1,0[illegible]

This section figured about 36 sq. ft. per foot of advance, making the actual cost on this work 27 ct. per square yard of surface coated. This cost, as will be noted, included the outside engineer, which charge would not be necessary in most cases. It is interesting to note the progress made, which approximated 90 sq. yd. per shift of 8 hours.

In addition to the main slope, the entries and breakthroughs are coated. The "gun" has also been used with success in making stoppings air tight and in building up permanent stoppings. This can be done by building up a wall of loose rock and then applying a thick coating of cement. An excellent air-tight stopping is the result.

Result.—It would seem that the coating has stood a sufficient length of time on the slope to enable one to judge as to its permanence. A large part of the coating has withstood the rigors of the coldest winter yet experienced, and the heat of an extremely warm summer. It is today in excellent condition and looks as strong and unbroken as when first applied. In a few exceptional cases only and that confined to small areas, has any spalling of the coating occurred. This was attributed entirely to improper cleaning of the wall before the coating was applied.

The beneficial results obtained at this mine have been such as to more than offset already the initial cost of the equipment and the cost of the work. Not a single fall of roof has taken place in sections coated, and, consequently, there has been no forced closing of the mine as was previously the case. This saving alone can be computed in dollars and cents.

Air Tools Used in Boring and Drift Bolting at Vancouver Pier.—In the construction of a 537-ft. by 160-ft. extension to the Vancouver, B. C., pier of the Canadian Pacific Ry., boring and drift-bolting was done by air tools, the air being furnished by a motor-driven air-compressor outfit. Pipe lines were laid from the compressor and connections tapped in with hose leading to air riveters with special sets for drift bolting and to boring machines. The borers proved particularly useful in putting down the 2-in. by 4-in. Australian hardwood flooring, which had to be bored for nailing. For this flooring alone 70,000 holes were required.

125-ft. Piles Used in Vancouver Pier.—Douglas fir piles 85 to 125 ft. long were used in the recently completed extension to the Canadian Pacific Ry. pier at Vancouver, B. C. The piles were creosoted with 15-lb. treatment under the boiling process. All deck timber which was either in contact with the water or near enough to be continually damp also was given a 12-lb. treatment. Approximately 2,550 piles were used. To put them down a special scow driver with 130-ft. leads was employed.

Mileage of Main Track Completed in 1918 Lowest Since Civil War

[illegible] terms of main track completed, and placed in service, was less than at any time since the Civil war. According to the annual statistical number of the Railway Age Gazette, [illegible] in this country, and only 135.08 miles in Canada. However, based on total expenditures authorized, railroad construction last year ranks well with recent years. This is accounted for by the record breaking amount of improvement work along existing lines that was carried out. The Pennsylvania R. R. alone, for instance, had under way over 200 projects, involving expenditures of over $100,000 each, and ranging from that figure up to $5,000,000.

The amount of second track completed in 1918 was larger than in any year since 1914, but is only about half the mileage completed in 1913. In Canada only 4.28 miles of second track was completed, with no additions to other than first and second main tracks.

In the United States the new mileage of first main tracks includes 59.7 miles on the Atlantic Coast Line in Florida, 53 miles on the Government Railway in Alaska, and 48 miles on the Gulf, Mobile & Northern in Mississippi and Tennessee. Most of the mileage of new lines, however, is in short sections, and a considerable portion is in connection with the development of coal lands.

Second-track work includes 64.05 miles on the Southern; 60.77 on the Santa Fe Coast Line from Goffs to Cadiz, Cal.; some 63 miles in short stretches on the Great Northern, and 48½ miles similarly divided on the Atchison, Topeka & Santa Fe. In general, the new second track mileage is in short stretches, following the policy of the Railroad Administration to secure additional mileage of second track where it could be obtained with the least effort. This applies also to the additions to multiple main tracks.

The following tabulation from the Railway Age Gazette shows the mileage of new track built in 1918 in the various states:

S[illegible]	[illegible] companies [illegible]	First [illegible]	[illegible] track.	Third track.	Fourth or more track.	Total.
Alabama	1	7.60				7.60
[illegible]		[illegible]	....			53.00
[illegible]	1	55.00	1.97			56.97
[illegible]	[illegible]	[illegible]	[illegible]			100.83
[illegible]	3	9.55	4.87			14.42
[illegible]					2.00	2.00
Florida		[illegible]				106.53
[illegible]	2	15.10	[illegible]			38.60
[illegible]						10.84
[illegible]	3	5.40	[illegible]	[illegible]	18.00	49.77
[illegible]	1	12.10	23.70	6.34		72.14
[illegible]			9.12			9.12
[illegible]		[illegible]				78.70
Louisiana			3.01			6.01
Maryland			7.87			21.17
[illegible]			7.47	5.96	0.33	14.56
[illegible]	1	0.17	2.42		0.50	7.53
[illegible]			0.66			
[illegible]			43.19	4.26	4.27	52.00
Mississippi		[illegible]	8.80			
[illegible]			13.27			14.28
[illegible]			57.71	1.07		[illegible]
[illegible]			12.58			12.58
New Jersey	2	5.93	7.24			13.28
[illegible]			12.08			12.08
[illegible]	5	6.57	30.31	12.29		[illegible]
[illegible]	2	6.30	15.83			[illegible]
[illegible]			4.36			4.36
[illegible]				19.20	15.62	
Oklahoma						6.28
Pennsylvania			34.03		6.60	87.21
South Carolina	1	38.80	41.72			80.52
[illegible]			4.00			24.00
[illegible]	3	39.70				60.66
[illegible]	2	16.13				
[illegible]			8.00			
Washington	2	7.53	2.30			9.83
[illegible]		60.57	32.19			92.76
[illegible]	1	5.00				
Wyoming		[illegible]	[illegible]			[illegible]
T[illegible]		[illegible]	[illegible]	[illegible]	57.43	[illegible]
Canada		[illegible]	[illegible]			[illegible]
M[illegible]		10.00				10.00

Some Results of a Year of Government Railway Operation

[illegible] by the [illegible] railroads for the [illegible] 1918 [illegible] by Director [illegible]. [illegible] from the report follow.

Lessons Learned from Operation of Railroads as One Unit.—[illegible] drawn from a year's experience of operation of the railroads as one unit. Given average weather conditions, and with the exception of [illegible] special treatment, [illegible] to transport [illegible] either domestic [illegible] for prompt dis[illegible].

The controlling factor throughout our experience has not [illegible] at the ultimate destination, and any serious conditions of congestion obtaining on [illegible] has been the reflex of the [illegible]. Practically all [illegible] had been based primarily upon the desires and necessities of the consignor rather than upon the abilities of the consignee to receive and digest [illegible].

Action Taken to Simplify and Economize Methods of Transportation.—This can briefly be stated as coming under the following general head:

Unification of terminals.—This has been general throughout the country at both large and small stations, but has been of the greatest importance at the larger terminals, where terminal managers have been appointed with jurisdiction over the facilities of all lines. Where unnecessary mileage was not involved, a consistent effort has been made to route freight so as to arrive at the specific terminal where it was to be disposed of, and, so far as practicable, interchange switching in terminals has been eliminated.

In Chicago terminals, it has been the practice under private control to reconsign practically all coal after arrival. By co-operation with producers, 66 per cent of the coal arriving at Chicago, in August, was consigned direct to consumer from the mines, and cross-hauling coal between terminal lines was greatly reduced through the same co-operation, whereby coal was used wherever possible upon the rails of the individual road over which it arrived.

Single track separately owned lines between Pueblo and Denver, 118.5 miles, and between Wells, Nev., and Winnemucca, Nev., 185 miles, have been utilized as double track.

The Southern Pacific; Atchison, Topeka & Santa Fe, and Western Pacific, each maintained passenger ferry service between Oakland and San Francisco. Santa Fe and Western Pacific passenger trains have been brought into the Oakland Mole of the Southern Pacific. The latter railroad's ferry facilities were ample for the three lines, so it was [illegible] with the ferry service of both the Santa Fe and the Western Pacific at an approximate saving of $315,000 per annum.

All railroad marine facilities in New York Harbor were consolidated under a marine manager, and have been used in common with very satisfactory results.

One hundred and seventeen coal-carrying barges and 18 [illegible] to the Philadelphia & Reading, Lehigh Valley, New York, Ontario & Western, and Erie Railroads were pooled under a single management.

All passenger trains of the Baltimore & Ohio and through passenger trains of the Lehigh Valley were brought into the Pennsylvania Railroad terminal in New York City.

Short hauling of freight.—Instructions were issued immediately upon the inauguration of Federal control providing for the movement of freight by the shortest practicable route. This practice has been consistently followed, except where better grade conditions and less congestion were favorable factors on a somewhat longer line. Agencies were created whereby failure to observe the correct routing was detected and remedied.

It is impossible, of course, to estimate the total saving accomplished in this direction. An instance, however, is [illegible] in the case of the Northwestern region, where the [illegible] of improper routing, within a period of five months on 34,941 car loads, resulted in a saving of 4,054,[illegible] car-miles.

Solid trains.—This practice was inaugurated of creating solid trains for definite destinations by building up at Chicago, Minneapolis and St. Paul, St. Louis and Missouri River crossings, which resulted in a natural decrease in intermediate terminal switching and the expedition of essential Government freight. This has been especially valuable in the transportation of export food of all kinds, meats, grain and grain products, and of munitions and steel for shipbuilding plants.

Elimination of non-essential passenger trains.—The question of duplicate and unnecessary passenger train service has been given the most careful consideration, with the result that a number of trains have been discontinued which fell in one of these classes. Between the important terminals the remaining trains have been so spaced as to actually afford greater variety and extent of service than was possible heretofore where, through competitive conditions, the trains on the several lines practically duplicated each other. The saving per year in passenger-train miles by regions is as follows:

Eastern	16,253,914
Allegheny	4,870,000
Southern	[illegible]
Northwestern	[illegible]
Central western	16,772,524
Southwestern	4,411,244

Common use of freight cars.

Common use of repair shops.

Use of New York tubes.—On account of the very serious conditions arising from the unprecedented ice troubles in New York Harbor, the Pennsylvania passenger tubes were utilized for the movement of anthracite coal from the Jersey terminals to Long Island, which afforded a very substantial relief at a most critical time. Under its franchise this could not have been done by the Pennsylvania Railroad under private operation.

Coal zone plan.—The experience of the railroads under private ownership, especially with a demand for coal far in excess of the tonnage produced, was that shippers reached out into markets far beyond the territory in which their particular coal had normally been sold in previous years. The result was a very considerable waste of transportation, in that a much greater car mileage, reasonably estimated as running into millions of car-miles, was necessary to supply the country with its normal coal requirements than would have been the case had shippers chosen to content themselves with normal markets.

To meet this situation the Railroad and Fuel Administrations jointly established what has come to be known as the bituminous coal zone plan of distribution.

Under this plan the various bituminous coal mining districts east of the Rocky Mountains were separated and each assigned a definite territory wherein it could market its coal. It was further provided that coal from any district could be shipped to destinations beyond the zone allotted to that district only upon permit of the Fuel Administration, which was recognized by the Railroad Administration as constituting exemption from the railroad embargoes which were laid down to give force and effect to the zone plan. This permitted proper distribution beyond zone lines of certain special grades of coal, coal for by-products use being a specific example.

The coal zoning plan, however, did not merely save car-miles, and thus permit the production and transportation of several millions more tons of coal than would otherwise have been possible; it furnished, in addition, the means of utilizing coal produced in the Plains States, which would not otherwise have been produced. This was made possible by prohibiting the shipment of certain eastern coal which the war program required to be kept in the East to territory in the West.

Transportation Performances in 1917 and 1918.—Because the cost of materials and labor have been steadily climbing, comparisons of transportation costs, expressed in money, are valueless, but the comparisons of physical performance afforded by these statistics are most instructive and helpful to the operating officers. For the first 10 months of 1918 we have the following comparisons in physical performance with the same period in 1917:

Ton-miles per mile of road per day	[illegible]	[illegible]
Tons per loaded car	[illegible]	[illegible]
Tons per freight-train mile	[illegible]	[illegible]
Total ton-miles per freight locomotive per day	[illegible]	[illegible]
Total ton-miles per freight car per day*	[illegible]	[illegible]

*The decrease in ton-miles per freight car per day was due entirely to the necessities for the long-distance movement of empty cars to care for emergency situations.

Blasting With Electricity

The following suggestions on the detonation of the blasting charges by electricity are abstracted from an article by A. S. Anderson in the December Du Pont Magazine:

Units Used in Electrical Blasting.—The detonator used is similar to an ordinary blasting cap with the exception that two wires enter through the open end, and the terminals are connected by a very fine platinum wire. This is imbedded in a loose ignition charge, similar to the pressed charge in the bottom of the copper shell. These wires are held in position by a composition plug and some melted sulphur and waterproof compound poured around them, to the end of this shell. Electric blasting caps are therefore practically air-tight and water-tight, and safer to handle than the ordinary open end blasting cap. This platinum wire has a resistance of less than 1 ohm and is therefore heated by an electrical current of about 1 ohm and 1 ampere. The heating or melting of this platinum wire ignites the charge and causes the cap to explode. It requires at least 1½ ohms and 2 amperes to melt this bridge.

Wires and Connections.—Because of the small amount of current necessary, small wires can be used to carry the current from its source to the exploders and between the various charges. No. 20 insulated copper wire is usually used on the exploders, and between charges. For the long distances between the source of power and holes, larger wire is recommended such as No. 14, to eliminate unnecessary resistance. The exploders may be connected in three ways: 1st, in series; 2d, in parallel; 3d, in two or more parallel series. It requires at least two amperes of current to explode the electric caps in one series, to insure instantaneous ignition of all exploders. One and one-half ohms are necessary to force this current through each exploder in this series. That is, 1½ times the number of caps in a series will give the necessary voltage. It is safer to use twice the number of caps to get the voltage. For each exploder or series of exploders two amperes should be used when they are connected in multiple. The voltage necessary for parallel connection can be determined by dividing by the number of series the voltage found necessary to force two amperes through the series which has the greatest resistance.

Kind of Connection to Use.—The series connection must always be used when a blasting machine is employed to explode the charges. The parallel, or parallel series, connection is usually used when dry cells or electrical generator is the source of the electricity for firing the blast. When multiple series connections are used the various series should be as near the same resistance as possible.

Ways of Producing Current.—Current for firing the blast may be obtained from three sources, the first and most common of which is the blasting machine manufactured for that purpose. They are built to fire from 100 to 200 exploders, depending upon the kind and size. They can be used only where the electric blasting caps are connected in series. That is because the amount of current produced is limited to about three amperes, while the larger machines will develop several hundred volts. When firing a charge with a blasting machine be sure that the machine is not overloaded, and test it frequently with a rheostat and exploders to make sure that it is up to capacity and in good working order. When a 3-post blasting machine is used, one wire should always be connected to the middle post. When three wires are used the wire from the middle post should be connected to the middle of the series. Thus the resistance on both sides will be equal.

When a lighting or power circuit is convenient, it can be used to fire blasts. One must be sure, however, that the amount of current and voltage necessary to fire the blast is actually being delivered at the desired point, and at the exact time the blast is made. It is not sufficient merely to tap a line which can deliver a certain voltage and amperage. For instance, the generator may be furnishing power irregularly and not be actually delivering that power at the time the blast is made. If a line is furnishing 250 volts and 10 amperes to some lights or a motor beyond the point where the line is tapped, this can be safely short-circuited to fire 125 exploders in one series, or five series of 625 exploders each. Such use of this current will not interfere with the operation of the motor or the lights, as it is used for too short a time.

Dry cells can be used for exploding electric blasting caps, but are not recommended as their deterioration makes their strength too uncertain. An ordinary telephone dry cell should produce 25 amperes and 1½ volts, when new. The amperage gradually decreases. One cell will heat the platinum bridge of an electrical exploder to a red or white heat, while two cells connected in series will melt it instantly. Two new cells will fire 12 exploders connected in parallel. For each additional exploder in a series it is necessary to add a cell. Smaller cells than this can be used as their voltage is the same, but the amperage is less. Extreme caution should be observed, when using dry cells, to make certain that the connection is not made until the desired time, when everyone is at a safe distance. Make sure also that the wires are not left connected to the cells.

States Can Use 103,000 Soldiers and Sailors on Road Work

The Bureau of Public Roads of the U. S. Department of Agriculture has collected from the highway departments of the various states figures indicating the probable number of returned soldiers and sailors that can be used during 1919 in road construction and repair work. Of the 38 states replying only 29 gave definite figures. They report they can use 11,637 soldiers and sailors as skilled laborers, and 91,904 as unskilled. Under the head of skilled labor the state highway departments were asked to report on the requirements of masons, carpenters, quarry bosses, concrete finishers, road foremen, roller men and superintendents. Unskilled laborers were not separated into classes.

The states that have thus far given definite figures, with the estimated number of men that may be used are:

	Skilled.	Unskilled.
Alabama	[illegible]	1,000
Arizona	[illegible]	[illegible]
Colorado		1,250
Delaware	100	1,000
Connecticut		[illegible]
Florida	[illegible]	4,315
[illegible]		[illegible]
Idaho		[illegible]
Illinois	2,500	15,000
Kansas	[illegible]	4,800
Kentucky	[illegible]	3,500
Louisiana	110	1,000
Maine	100	1,000
Massachusetts	[illegible]	2,000
Michigan	200	[illegible]
[illegible]	[illegible]	4,800
[illegible]		2,000*
Montana	[illegible]	644
[illegible]	[illegible]	2,250
[illegible]	35	[illegible]
[illegible]	[illegible]	1,000
[illegible]	[illegible]	7,000
[illegible]	[illegible]	[illegible]
Rhode Island	[illegible]	[illegible]
South Carolina		1,500
[illegible]	900	5,100
Washington		[illegible]
West Virginia	700	9,300
[illegible]	600	7,500

*[illegible]

Railways Expend $11,000,000 Annually for Maintenance of Way Painting.—The total expenditures of Maintenance of Way painting by the railways of the United States aggregates close to $11,000,000 per year, according to figures submitted in a committee report at the last annual convention of the Maintenance of Way Master Painters' Association. Of the total $7,400,000, representing 22,000,000 hours, is for labor. The labor required in this painting aggregates 82 hours per mile at a cost of $27.

Electric Railway Snow Fighting Equipment and Its Applications

An interesting review of the different types of snow fighting equipment employed by electric railways, and their application is given by Mr. J. M. [illegible], Railway Engineer, Westinghouse Electric & Mfg. Co. in Aera. Extracts from his article follow.

The Use of Brushes.—On some roads, stiff brushes of [illegible] which have been installed ahead of front car wheels. These have given fair success on city tracks when the snow fall was light in keeping the rail clear, but as they merely push snow off of the rail to the inside and outside, they are not to be depended upon to maintain service during heavy snow fall. They are used, however, with success in keeping third rails snow free on roads using this system of current collection.

Snow Scrapers.—Snow scrapers, backed with heavy springs, installed on a beam ahead of the front wheels, satisfactorily keep rail and flangeway clear of snow and throw out the snow to a much greater extent than snow brushes. Revenue cars equipped with scrapers and an additional scraper between them to keep down snow in center of tracks, will do much toward keeping tracks clear if run at frequent intervals. In paved streets, where brooms are used to keep centers clear, the two scrapers ahead of wheels are desirable to keep snow out of flangeway.

Snow Sweepers.—Snow sweepers are the main stand-by for street car systems when they are put out on all lines as soon as snow starts to fall. They should be equipped with "wings" in order that snow which accumulates beside the track out of reach of the brooms may be shoved back near the curb line. These brooms should be set to just reach the pavement and not set so low that they become "pavement polishers," wearing out splints rapidly and not removing snow properly.

Snow Plows.—As a rule, plows have their application on suburban, interurban and standard steam roads, although it is necessary to use them on some city properties. On roads running long headways, plows should be run ahead of regular cars during storms as much as possible. Plows are efficient to the point where snow becomes banked to such a height beside the roadway that the plows are unable to throw the snow from the track to top of this bank. Plows properly motored can get through large drifts if there is any open space beyond the drift where the snow may be pushed to. The plow should be applied to car in such a manner that it may be raised and lowered when going over guard rails and special work. This is usually accomplished by a system of levers operated by a common brake cylinder and compressed air.

Rotary Plows.—Rotary plows have their application to about the same class of roads as the snow plow, and their use is to clear tracks when snow banks have become so high that plows are not able to throw out the snow. They are more efficient at any time during a storm than a snow plow as the snow is thrown farther back from the track. The rotary scoops are raised and lowered in same manner as nose plow when going over special work.

Flangers.—This term refers to apparatus mounted between car trucks, which consists of steel plate set at an angle, used to clean out track centers to the top of, and sometimes below, surface of rail and to some distance outside of rails. These flangers are used to a great extent on steam roads and may be operated by any road using open rail. They are raised and lowered by air over special work. Painted sign boards are usually placed beside tracks to indicate guard rails and special work as a guide to the flanger operator for raising and lowering flanger.

General Use Equipment.—Railway operators, as a rule, do not desire to purchase any car equipments which can be used to advantage only a few months of the year which is probably the reason so few snow equipments are kept on hand for emergencies. But snow fighting cars are now built which should rule out this objection. Snow sweepers and nose plows are so constructed that the brooms and plows may be removed at a season when they are not needed and cars used for freight or work train service, until they are again needed for snow work. On rotary plows and snow sweepers where it would not be feasible to do this, cars may be placed on blocks when not needed, trucks and motors used as spares during the overhauling period in the summer to prevent keeping revenue cars out of service for long periods.

For city properties, snow sweepers and scrapers are usually sufficient to take care of snow, but in some localities snow plows and even rotary plows are needed also. On the average interurban property which would desire the most efficient car for all-round snow fighting and one which might be used for other purposes during non-winter months, would be one equipped with nose plow at each end of car, flanger installed between trucks, wings installed at the sides, air compresser and electrical apparatus installed inside car and so arranged that plows and flanger might be readily removed and set aside when not needed, air compressor and electrical apparatus placed under car and car used in freight and work train service. Roads having very heavy snow fall every winter or bad drift conditions to meet should also have rotary plows at hand. Bad drifts on the right of way could be eliminated to a great extent if snow fences were used at the proper points.

Causes of Trouble Due to Snow.—Most railway operators agree that most serious trouble occurring due to snow is the matter of high track centers, on which the motors drag and derail the cars, roast out motors, cause spinning of wheels and service tie-ups. Next in line are delays and equipment burn-outs due to bucking deep snow and snow drifts. With the equipments mentioned in this article, properly used, service may be maintained satisfactorily, but as there is no such thing as a standard snowstorm, equipments must be used as conditions require. A heavy fall of snow and no wind may usually be combated by frequent service over the lines and snow equipments, but with a light snow and strong winds, snow will sometimes drift so rapidly that a few minutes after snow equipments have gone through, tracks will be completely filled in again. Under the last conditions mentioned, it is certainly good practice to have the snow equipment car run directly ahead of passenger cars since all this may mean less passenger cars run. Nothing is gained by bucking through snow with a passenger car not equipped for this work, unless it is the satisfaction of "getting her through," and if this policy is followed a few cars may get through and a sort of service keput running during the storm, but so many equipments will fail getting these few cars through that service will be out of kilter for days or weeks until the repair bill will total a sum unpleasant to contemplate.

There are occasional cases where a carload of passengers might be stalled out in the country on interurban roads where suffering might result from exposure and under such conditions it is certainly necessary to buck through and get in if at all possible. If good judgment is used and equipments allowed to "rest" and cool down after numerous strenuous efforts made to get through, the equipments may not be affected to any great extent. However, under any conditions, it is folly to burn out all of the motors when it can be plainly seen that car has not the power to get through.

Snow equipment cars and trucks should be strongly built and equipped with best motors obtainable and large enough to have sufficient reserve to take care of the heavy duty required of them. It is a common, but faulty, practice among some operators to use obsolete and run-down motor equipments, which cannot be depended on in passenger service, on their snow-fighting cars, and usually just when they are needed most they fail. The purpose of snow equipments is defeated by this practice.

A large number of motors fail when operating through snow, due to snow getting in the motors, melting, and causing flash-overs and insulation break-downs. Most cases of this nature might be avoided if tracks are kept free of snow, but during snow periods motors should be given more attention, drain holes kept open and interiors cleaned of snow.

New Government Bureau for Reviving Construction

As noted briefly in our Jan. 8 issue a new division in the U. S. Bureau of Labor has been created for the primary purpose of reviving public works construction and private building enterprises. This bureau—the division of public works and construction development—will gather and distribute information that will enable private initiative to make the transition from a war to a peace basis without serious interruption, obviating uncertainty or hesitation for want of the practical data upon which business judgment must depend. The survey will be concerned particularly with data of significance to the construction industry; but the data required for reasoned action in this industry are extremely varied, and the information brought together by the division is expected to be of value to industry in general. The work of the division is a nation-wide search for facts that may be weighed by any community or investor in attempting to determine whether it is sound judgment to construct a particular public work or private building at present. The results of the inquiry will have the widest publicity, and when circumstances unfavorable to construction are discovered efforts may be made to change them, but nothing will be done to stimulate economically unsound enterprises.

The pivotal nature of the building industry in economic reconstruction and the general purpose of the work of this division are expressed in Secretary Wilson's statement:

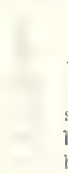
> Building construction will help to provide employment for returning soldiers and for workmen [illegible] war industries. One of the largest [illegible] is the building trade and its allied [illegible].
>
> In the case of private construction [illegible] will also lessen the congestion [illegible] affecting the public health [illegible] property which [illegible] communities to support the [illegible].
>
> During the war the nation [illegible] efforts on the production of goods for immediate consumption [illegible] materials, food, clothes. The [illegible] of goods for [illegible] high priced, and [illegible] the effect the cost of [illegible] high rents.

An interesting feature of the organization of the division is the manner adopted to insure obtaining information of practical value to those who are primarily expected to use it. The general scope of the inquiry is determined by a section, composed of non-paid members who are business men of practical experience. The inquiry itself is directed by a group of economists and special investigators supplied by the Department of Labor and other Government departments or borrowed from universities.

The economists are collecting information concerning the cost and supply of building materials, the amount of labor available and its cost, the values of land, prevailing rents, the supply of capital, the amount of building construction held up by the war, and the demand for building in various parts of the country.

Five other sections will prepare information for publication under the supervision of the economics section and disseminate it through the press, public speakers and posters and by enlisting the co-operation of organized labor.

Safety Drop Hook for Skull Crackers



Skull crackers are often used by contractors for breaking up concrete. A safety drop hook which will largely eliminate the possibilities of a premature dropping of the ball is shown in the sketch. At steel and iron plants where the skull breaker is in general use the ball is commonly held by a magnet. In this case it is important that the electrical circuit be kept in perfect repair.

Status of 1918 Railway Improvement Program

On Feb. 2, 1918, all railways under federal control were directed to send in budgets of improvements immediately required to increase capacity and efficiency and to promote [illegible] expenditures chargeable to capital account—that is, exclusive of large sums chargeable to maintenance—amounting in the aggregate to $1,329,000,000 which, upon careful revision was reduced to $975,000,000. This amount has been increased from time to time by new and unforeseen requirements, and particularly by large orders for locomotives and freight cars, until the improvements definitely authorized to Dec. 1, 1918, amounted to $1,254,396,158. Of this amount $551,925,525 is for additions and betterments; $656,048,745 for equipment, and $46,421,888 for construction of extensions, branches and other lines. In a statement of Director General McAdoo on Jan. 3 before the Interstate Commerce Committee of the U. S. Senate the status of these improvements was outlined as follows:

[illegible]	[illegible] Dec. 1.	Capital [illegible] Nov. 1.
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
Water stations and appurtenances....	11,879,643	5,046,824
[illegible]	[illegible]	[illegible]
Shop machinery and tools.....	21,585,247	6,383,153
Electric power plants, substations, etc	22,454,729	5,742,126
[illegible]	[illegible]	[illegible]
Coal and ore wharves	5,532,284	3,621,739
Grain elevators and storage warehouses	2,747,663	2,111,911
[illegible]	[illegible]	[illegible]
Assessments for public improvements	3,063,271	1,385,321
All other improvements	7,814,181	4,473,332
[illegible]	[illegible]	[illegible]
Work equipment	7,677,891	1,748,404
[illegible]	[illegible]	[illegible]

In planning improvements chargeable to capital account other than for war purposes, the rule adopted was that the first consideration should be safety in operations; and secondly, increased capacity where that was needed and that any improvement not required for these purposes should be deferred until after the war unless exceptional circumstances should make it necessary earlier. Improvements designed to effect permanent economies have been left for the favoring times and conditions of peace, unless the economy was so great that substantially the entire cost could probably be saved during federal control.

The effect of the foregoing policy is shown by the above statement, from which it appears that much the largest item was for additional yard tracks, sidings, etc. The second largest item was for shop buildings, engine houses, and appurtenances; and the third for additional main tracks;

and by the large orders for equipment almost wholly for locomotives and freight cars.

Size of Lamps and Area Illuminated in Outdoor Lighting

The following note on lighting yards at industrial plants is taken from a recently issued bulletin of the National Safety Council.

The illumination at any point should be secured from more than one direction to avoid deep shadows at possible danger points. This limits the area it is desirable to illuminate from a single point. Yard lighting lamps should be mounted at least 20 ft. above the ground level, higher if possible to lessen the shadows and minimize glare. If the lamps must be installed lower than 20 ft., they should not be larger than 100 watts. Shallow-bowl porcelain-enameled reflectors of a weather-proof type may be used to good effect. The spacing between units should not exceed four times the height above the ground (unless special prismatic refractor units are used). Several plants have found the following standard satisfactory, corresponding to an intensity of one-fourth foot-candle:

[illegible]	Most suitable size of lamp
[illegible]	100 watt
[illegible]	150 watt
[illegible]	200 watt
6,000 sq. ft.	300 watt
[illegible]	400 watt
[illegible]	500 watt

Excavation Tables.—The State Reclamation Department of Texas, Austin, Tex., has just brought out a bulletin supplementing its bulletin No. 5, "Tables of cubic contents of level embankment." The new bulletin contains factors for obtaining cubic yards in sloping cross sections from cubic yards on level cross sections, and also tables of base width and vertical heights on level cross sections with zero crowns. The bulletin is intended to be used with Bulletin No. 5, but it can be employed with any other earthwork table based on level cross sections. It was prepared under the direction of Arthur A. Stiles, State Reclamation engineer. Copies of this Bulletin 5-A, can be obtained free from the Reclamation Department. The supply of Buletin 5, however, is exhausted.

News Letter

St. Louis Items.

Schaefer Bros.' Contracting Co., St. Louis, Mo., want a 20 [illegible]. Will contract the job or hire teams [illegible].

Mulvill Bros., Alton, Ill., would like to get in touch with someone that has a Sauerman bucket and cable machine outfit that is [illegible].

Robt. M. Gurley, representing T. W. Snow Construction Co., was [illegible] last week with a new record of stories that he brought in from the Northwest.

Contractors when in want of labor or work for their outfits write the old reliable Koenig's Labor Agency, 612 Walnut street, St. Louis, Mo., or 503 Delware street, Kansas City, Mo.

Geo. Condon passed through St. Louis on his way to Omaha to spend the holidays with his family. Condon reports his work on the Illinois Central R. R. in Kentucky as getting along nicely.

The East Side Levee and Sanitary District, the National Stockyards interests and the Director General of Railroads have agreed upon a plan of eliminating Cahokia Creek, which passes through East St. Louis, Ill., by the construction of a large sewer from the stockyards directly west to the river. The cost of the construction is to be divided between the three parties mentioned and the ground accumulated by filling the creek will become the property of the railroad.

The citizens of St. Louis are going to vote on a $23,349,000 bond issue this spring. The items in the tentative budget are:

[illegible]	$10,495,000
[illegible]	3,420,000
[illegible]	2,850,000
Municipal auditorium, joint ownership plan	1,000,000
Municipal farm	400,000
Belt railroad from No. 1 and Victor street docks	1,900,000
Grade crossings and viaducts, city's share	1,934,000
Street openings and widenings, city's share	1,000,000
Fire engine house and equipment	200,000
Industrial farm, Bellefontaine	150,000
Total	$23,349,000

The labor market is easier right now than it has been at any time within two years. Plenty of labor for any kind of work. Don't look for the situation to change until the 15th of April or 1st of May.

A. B. Koenig.

Personals

L. B. Martin, heretofore superintendent of maintenance of way of the [illegible] Traction System, has been made general superintendent of interurban lines.

H. T. Sympson, assistant division engineer of the eastern division of the Pennsylvania R. R., Western Lines, with headquarters at Pittsburgh, has been appointed division engineer, with headquarters at Columbus, O.

Richard H. Gillespie, formerly chief engineer of the Borough of the Bronx, New York City, has been appointed general manager and chief engineer of the Dewey Cement-Gun Construction Co., with offices at Allentown, Pa.

Dr. William T. Lee, head investigator for the U. S. Geological Survey, has been selected as head of the geology department of the University of Oklahoma. Dr. Lee becomes professor of geology and director of the School of Geological Engineering.

Joseph H. Lyons has been appointed superintendent of transportation for the municipal street railway of Tacoma, Wash., which came under city supervision Jan. 1. The line has been operated by the Tacoma Railway & Power Co. on a contract with the city.

Friend P. Williams, formerly division engineer of the western division of the New York State Barge Canal, has been appointed second deputy state engineer. Leroy C. [illegible], formerly acting division engineer of the eastern division, succeeds Mr. Williams.

Hugh A. Brown of Urbana, Ill., has been elected head of the department of physics and engineering at Ottawa University. The chair has been vacant since Prof. [illegible] was granted a year's leave of absence to take up war teaching work in Manhattan. Prof. Brown is a graduate of the University of Illinois, taught three years in the University of Arkansas, and until recently was a teacher in the aeronautics school at Urbana, Ill.

F. N. Holmquist has been appointed State Engineer of the State of Arizona, vice B. M. Atwood, resigned, this change taking place on Jan. 6, 1919. It is understood that Mr. Atwood intends to go into contracting, particularly in connection with road work. Mr. Holmquist has been in private practice in the city of Phoenix for a number of years, prior to which date he was City Engineer of Phoenix. Mr. Holmquist was graduated from the University of Illinois in the class of 1909 and has been in Arizona for the greater portion of the time since that date.

Brig. Gen. Henry W. Thornton, formerly general superintendent of the Long Island R. R., has been raised to the knighthood by King George in recognition of his services to the British nation during the war as general manager of the Great Eastern Railway of England. During that critical period in the war, when holding the western front depended largely upon the swift movement of British troops, Gen. Thornton handled the British railway system with such efficiency that his work has won for him the title of Knight Commander of the Order of the British Empire. Gen. Thornton was born in Longport, Ind., in 1871 and is a graduate of the University of Pennsylvania. He became a citizen of Great Britain in 1916, 3 years after he took over the management of the Great Eastern.

Capt. George F. Daggett of Brooklyn, N. Y., has been appointed chief of the Transit Bureau of the Public Service Commission for the First District, New York City. Capt. Daggett succeeds J. P. H. DeWindt, who resigned several months ago to undertake the management of a munitions plant. The chief of the Transit Bureau is the officer upon whom the Public Service Commission relies to supervise the operations of the several transportation lines in the city, to investigate complaints and to inaugurate improvements in service where needed. Capt. Daggett has recently returned to the commission after a year in military service. He entered the employ of the commission shortly after its organization in 1907, and latterly has filled the posts of chief clerk and assistant secretary.

Obituaries

Dr. Angus Sinclair, publisher of Railway and Locomotive Engineering, and a well known writer on railway matters, died Jan. 1 at Milburn, N. J., aged 78.

Maj. Charles F. Cook, 35 years old, purchasing agent of munitions for the Ordnance Department of the United States Government, died Jan. 11 in St. Luke's Hospital, New York. He formerly was employed by the J. G. White Engineering Corp.

Walter V. Turner, manager of engineering at the Westinghouse Airbrake Co., an authority on pneumatics, died Jan. 9 in Columbia Hospital at Pittsburgh following a general breakdown in health. More than 400 inventions in use on railroads and in industrial plants are credited to Mr. Taylor.

Industrial Notes

The Blaw-Knox Co., Pittsburgh, Pa., announces that Ensign Irving Burrows has been released from the service of the government and will reopen the company's San Francisco office at 528 Second street within a couple of weeks.

Trade Publications

Walter A. Zelnicker Supply Co., St. Louis, Mo., has issued Bulletin No. 250, listing rails, locomotives, cars, cranes, shovels, contractors' equipment, etc., carried in stock by the company.

The Blaw-Knox Co., Pittsburgh, Pa., has issued the third and revised edition of the booklet describing and illustrating the "Blaw" single line clamshell buckets. The operating and construction features of the buckets are described fully in the booklet.

The Lidgerwood Mfg. Co., New York, has issued Bulletin No. 19, covering its lines of steam mine hoists. It contains descriptions of the company's standard line of steam mine hoists, and describes a few of the many type of hoists developed by the company to meet special conditions.

The Lakewood Engineering Co., Cleveland, O., has brought out a booklet that through its pictures and text tells an interesting story of the part of the American engineer in the world war. The booklet is entitled "The Road to Peace." It is excellently gotten up and contains many war photographs of unusual interest.

Building and Structural Issue

ENGINEERING AND CONTRACTING

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The *articles* in the first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering and contracting field. The *articles* in the first and last issues of each month (1st and 4th Wednesdays) completely cover county engineering and highway engineering and contracting. The *articles* in the third and last issues of each month (3rd and 4th Wednesdays) completely cover steam and electric railway location, design and construction. See the "mast head" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power

Railways and Govt. Works—3rd Wednesday
(a) Excavation and Dredging
(b) Rivers and Canals
(c) Harbors and Docks
(d) Railway Construction

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Ship Construction
(d) Miscellaneous Structures

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E. & C. Index Furnished Only on Request

Hitherto it has been customary to send the index of our articles to every subscriber. In order to conserve paper the index for the six months ending Dec. 31 will be sent only to subscribers who send a postal card or letter requesting a copy of the index. We will then list your name so that you will receive the index twice each year without the necessity of writing us. It will assist us if those desiring the index will notify us at once.

Language As a Tool for Reasoning

Language is commonly regarded merely as a device for conveying ideas. It would be well were it more often looked upon as a tool with which to reason. Language is quite as essential for a soliloquy as for a dialogue, and it is more often used for the former—at least by thoughtful men—than for the latter. Words are symbols, and the things they symbolize are always some form of energy or the four categories of energy—number, mass, space and time. But a symbol is meaningless except to the person who has himself perceived or sensed the class of thing symbolized.

Hence the extreme importance of sensing a thing at the same time that its name is learned. Hence, also, the desirability of combining theory with practice, language with action.

One of the defects in the training of many engineers has been an insufficient study of the symbols with which they reason. On the other hand, a great defect in educating lawyers has been an insufficient training in the sensing of things. In them we consequently see disproportionate attention to language, even as we often see in engineers a disproportionate attention to the physical things denoted by words. The lawyer, for example, weighs every word of a specification very carefully, and frequently gives so much attention to the phraseology that he neglects the final aim of the contract, which is to secure a given end in an economic manner. The engineer, engrossed in the economics of the problem, is quite likely to be slipshod in his verbal statements of the means to be used to secure the desired end.

In order to rectify the tendency to use language carelessly, engineers should study formal logic. It is true that Aristotolean logic places too great emphasis on the "form," and too little on the "substance," but engineers will find this emphasis an excellent correction of their tendency to slight the "forms" of expression. They will also come to see more clearly that systematic study of language as a tool for reasoning is a very great help for thinking correctly.

Two things having the same class name often differ very much, except as to a few class characteristics, yet there is a strong inclination to regard things of a class as being alike in almost all respects. The inclination is so strong in people who have studied neither logic nor language that they often make errors otherwise inexplainable. Thus there are many intelligent men who have such a horror of the word "debt" that they oppose every proposition to issue bonds for public works. They see no distinction between a personal debt and a joint ownership in a plant such as a bond virtually assures to its owner. Similarly there are many men who still think that all depreciation is of the same nature because all depreciation involves loss of value; and they reason about functional depreciation precisely as they reason about natural depreciation, and therefore erroneously.

To be able to see the various subclasses behind the class names comes instinctively to some men, but to most men [illegible] both in language and [illegible] the [illegible] groups [illegible].

"The Time Will Come When People Will Ask, Not Who Paid for a Thing, But Who Built It"—Hoover

Aside from President Wilson no American has been so widely advertised by his acts during the war as Herbert C. Hoover. [illegible] prior to the war, Mr. Hoover has steadily proved his right to be called a truly great executive, so great in fact that his name has frequently been suggested as fit to be enrolled as a successor to President Wilson himself.

In acknowledging his recent election to the Italian Royal Academy of Science, President Wilson said: "While perhaps there is no science of government, there ought to be." Had Mr. Hoover been speaking, instead of the President, we believe he would not have said that "there is no science of government," for to the modern engineer every sort of administration involves the application of science. Listen to what Mr. Hoover wrote not long ago:

"The engineering profession generally rises yearly in dignity and importance as the rest of the world learns more of where the real brains of industrial progress are. The time will come when people will ask, not who paid for a thing, but who built it. To the engineer falls the work of creating from the dry bones of scientific fact the living body of industry. It is he whose intellect and direction bring to the world the comforts and necessities of daily use. Unlike the doctor, his is not the constant struggle to save the weak. Unlike the soldier, destruction is not his prime function. Unlike the lawyer, quarrels are not his daily bread. Engineering is the profession of creation and of construction, of stimulation of human effort and accomplishment."

The Engineer As the Power Behind the Construction Company Throne

"The offices in this country that have great architectural reputations do not exist solely because of the quality of their architectural work. They survive, first, because they are business getters—regardless of their devious methods of obtaining work—and second, because in each organization there is a power behind the throne. The power is usually an engineer! He has an understanding of, and an appreciation of, matters architectural because he is educated and a gentleman."

The foregoing is a quotation from a paper by Oscar Wenderoth, former Supervising Architect of the U. S. Treasury Department. The paper will be found on another page under the title of "Constructive Criticism of Architects," and it can be read with profit by all structural engineers.

During the past fifteen years civil engineers have largely emancipated themselves from the economic slavery of pure professionalism, and have consequently come, more and more, to be regarded as business economists. They have not hesitated to adopt old business methods and to create new ones. Among these new creations there is to their credit the sort of construction firm that not only designs buildings, but erects them, and not infrequently finances the building project for the client. So successful have many of these construction companies become that architects of the old school are at least beginning to consider the wisdom of imitating their methods. Mr. Wenderoth's article is only one of several of the same sort that we have published within the last year, urging architects to follow the lead of structural engineers in advertising, in soliciting and forming construction companies composed of architects, engineers and business men. Mr. Wenderoth says: "Such a group must be made up of a business getter, a master of architectural design, a structural engineer, a business administrator and a technical director. An organization thus constituted is a business organization, by no stretch of the imagination could it be considered as a professional organization."

We do not agree with this last sentence, such an organization is neither a business organization nor a professional organization, for it is a combination of the two. It is this novel combination that certain engineers invented a few years ago, and it was invented by engineers because engineering had itself come to be a combination of applied science and business economics.

Mr. Wenderoth's closing advice to architects is: "The only way the architects can meet this new situation and save themselves is to change their point of view, reorganize as business institutions and by building better, more economically and more efficiently try to meet the growing competition of the architectural and engineering contracting firms that already are taking work away from them."

Engineers and the Public

Public libraries quite generally have been regarded either as places of entertainment or as storage rooms for instruments of amusement. But the younger librarians, particularly those who have received special training for their profession, are doing a great deal to change the popular conception of what a public library is or should be. Thus, in the last issue of "Pacific Municipalities," Joseph F. Daniels gives an interesting discussion of the "Public Library as a Central Power Plant," a public activity, a plant whose product is not only useful but saleable.

Mr. Daniels tells how the public library of Riverside, Cal., sells service to the county, to school districts, to library school students and others. It is not of the $12,000 annual income from such sales of service that we wish to speak, but of the extension of public library service to engineers and architects.

If the engineers and architects in every city would take an active interest in the public library it would not be many years before there would be available for their use a large collection of technical books. In many a city it would be well if the libraries of engineering and architectural societies were located in the public library building. Then if those societies would offer to duplicate all appropriations made by the city council for technical books, there should be no great difficulty in persuading the "city fathers" to assist in building up a really creditable scientific library.

Engineers who are inclined to complain that the general public does not appreciate them might find it wise to cease complaining and take steps to make people realize the scope and importance of applied science. The very act of frequently going to the city council to secure appropriations for engineering books and magazines would serve to make at least a part of the public realize that engineering is a progressive science backed by progressive men. Then as an increasing number of the shelves in the public library become loaded with technical books there would come a growing general respect for the erudition and practical knowledge of the sort of men who use this "central power plant."

A Definition of Engineering

To the Editor: I have been interested in reading the recent definitions of Engineering, and herewith give one that seems to fill the bill, at least in the way I look at it.

Engineering is the application of mathematical principles to the requirements of humanity.

An engineer is one who makes these applications. If he applies them to the design of bridges, he is a Bridge Engineer. If he applies them to the generation, distribution and use of electrical current, he is an Electrical Engineer. If he applies them to the problems connected with the supply and distribution of water for domestic purposes, he is a Waterworks Engineer. And so the list may be extended.

BENJAMIN THOMPSON.

Tampa, Fla.

A Crane Girder Problem

By R. FLEMING,
American Bridge Company, New York City.

Bridge girders of electric traveling cranes are usually of the box type with a walkway on the side of one girder. When the walkway consists of two or three planks supported by light brackets the overturning moment is so small that in designing the girder it can be neglected. But the requirements of "Safety-first" and improved electrical equipment have greatly increased walkway loads. The "General Requirements for Safety" (1918) of the U. S. Steel Corporation call for footwalks to extend entire length on both sides of the bridge, to be built entirely of steel, to pass underneath and around instead of over bridge motor, to have railing of two horizontal members, and floors to be of checkered plate not less than ¼ in. thick with toe guard 6 in. high. For cranes of large capacity these loads are still a small proportion of the total load, but for cranes of, say, 5 or 10 tons with long span they should be taken into account. Crane makers have no standard practice in making provision for stresses caused by these loads.

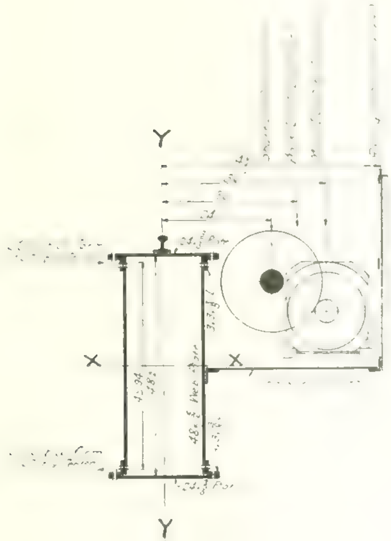

Fig. 1.

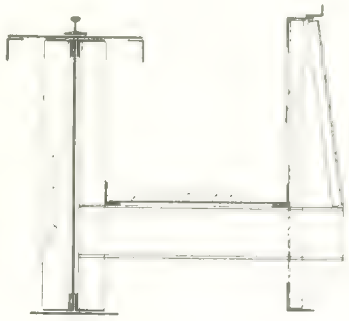

Fig. 2.

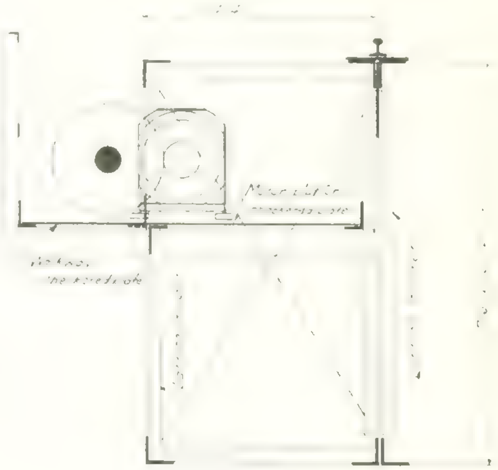

Fig. 3.

Figure 1 shows a cross section near the center of the walkway girder of an 80-ft. span crane with the loads carried by the walkway. What are the stresses in the girder due to the overturning moments of these loads? The problem is the determination of torsion stresses in a hollow rectangular prism with re-entrant angles. As yet it is unsolved.

In 1855, St. Venant, the great French elastician, published his "Memoire sur la Torsion des Prismes, ———," the classic treatise on torsion. An excellent synopsis of this treatise may be found in Thomson [Lord Kelvin] and Tait's "Treatise on Natural Philosophy," Vol. 1, Part 2, and an even better one in Todhunter and Pearson's "History of the Theory of Elasticity," Vol. 2. Burr establishes in his "Elasticity and Resistance of the Materials of Engineering" some of St. Venant's formulas, but most writers accept his conclusions without question. For non-circular sections the unit torsion stress does not vary as the distance from the center; the maximum stress occurs at a point on the perimeter nearest the axis of twist and there is no stress at the corners of square and rectangular sections.

St. Venant gives but 5 of his 327 pages of the torsion of hollow prisms. No help is found for the problems on hand.*

The formula given by Unwin, in his "Machine Design," for hollow rectangular prisms applies only where the two rectangles are similar. For instance, if the outside rec-

be included) to act as separate girders fixed at the ends.

tangle [illegible] in. and the shell should measure ⅜ in. thick on the short sides, the formula would not be applicable unless the shell were 0.09 in. thick on the long sides.

An English textbook, "The Calculation for Steel Frame Structures," by W. C. Cocking, has a short chapter, "Eccentric Loading of Beams." The author frankly says he knows of no correct method for computing stresses in the flanges of beams of I or box section due to eccentricity of loading. He determines the lateral bending moment on the flanges equivalent to the overturning moment. The flanges are assumed to act as two separate girders freely supported at the ends, and the stresses are found from the bending moment by the ordinary formula for flexure. The stresses thus obtained are arbitrarily divided by 2. This method, however, gives stresses too small for plate girders and too large for box girders.

The writer suggests that for determining the unit stress in a box girder due to overturning moment the following method be used until further knowledge is obtained: Assume each flange (one-sixth of the area of web plates to

Reduce the vertical couples due to overturning to equivalent horizontal couples acting at the centers of gravity of the flanges and find the unit stress from the common flexure formula. This stress should be added to the unit stress due to vertical loads.

Following this method the walkway loadings of Fig. 1 reduce to equivalent horizontal couples as shown. Considering each flange as a beam with fixed ends the bending moments are

$$\text{From uniform load, } \frac{3200 \times 960}{24} = 128000 \text{ in. lb.}$$

$$\text{From concentrated load, } \frac{1567 \times 960}{8} = 188000 \text{ in. lb.}$$

or a total moment, $M = 316000$ in. lb. The section modulus, I/C, for the flange $= \frac{1116}{12} = 93$. From the flexure formula the stress S in pounds per square inch $= M \div I\ C = 316000 \div 93 = 3400$. For the maximum unit fiber stress in the flange this should be added to the stress about the axis XX due to vertical loads.

Diaphragms should be placed at each bracket and not farther apart than twice the depth of the girder. To prevent "dishing" of the cover plate they may need to be closer but the intermediates need not extend the whole depth.

Figure 2 is a cross-section of the girders for a 10-ton crane, 66 ft. span. This particular crane has a walkway on each side. There are no overturning moments to be resisted and the crane rail is directly over the web plate of the girder. The outer girder is of a light lattice type and acts as a rail-

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*The writer has never seen St. Venant's "Memoire" and is dependent upon the synopsis [illegible].

[illegible] similar to the [illegible]

[illegible] of the girders on the walkway side of a [illegible] All the girders are of lattice type. The walkway is outside the stiffening girder. After the crane was erected it was found necessary to move the operator's cage to near the middle of the span in order to give an unobstructed view of the yard. If the girder had [illegible] been impracticable.

How Engineers May Obtain Publicity for the Profession

Opportunities for publicity work by engineers were outlined by the committee on publicity of the Iowa Engineering Society in its report submitted at the last annual convention. Three methods were suggested: publicity by individuals, press publicity and publicity by local engineering societies.

Publicity by Individuals.—Every member may help advertise the engineering profession by his personal conduct. Optimists will be popular. Take your hard luck stories to bed with you and get up without them. Tell the good things you know about engineers, but keep mum about the bad things. When it is for the good of the profession to tell the faults of another engineer, speak out, but stick to the facts which you know. Every boost for the engineering profession is a boost for yourself.

Advertise the profession by your personal influence in your community and build up your influence by getting into public affairs. F. W. Hanna, Consulting Engineer of the United States Reclamation Service, has said:

> [illegible] turn of mind, his accuracy of [illegible] and his [illegible] are excellent qualities for [illegible] greater endeavor on the part of the [illegible] public appreciation and better preparation of [illegible] for public service will aid greatly in [illegible] of appointments and elections to [illegible] and influence.

Isham Randolph, Consulting Engineer, has said that there would be more engineers rightfully in prominent positions, both in public and private business life, if more engineers had taken supplementary courses in the great graduate school of American politics.

Press Publicity.—Editors will be glad to use news items about engineering and engineers, which are of interest to the readers of their papers. Most engineering work in Iowa is of only local interest and every engineer should become the profession's press-agent for his vicinity.

Special feature articles will be given wider circulation, but must be of general interest and well-written. C. E. Drayer tells in last year's proceedings of the Ohio Engineering Society how the Cleveland Engineering Society got a page in a Sunday paper for an article on "How Gunners Pick Out Their Targets Though Far Away," a page about "Why No Boat Can Withstand a Torpedo," a two-page article entitled "Visit New Stars Through Cleveland-Made Telescope," and numerous other special articles and news items, which advertised the engineering profession.

Circulars of information for persons desiring or needing engineering services, and bulletins for our members on local publicity, ethics and the like would be "worth while" publicity work for the society.

Publicity by Local Engineering Societies.—Mr. Drayer, formerly secretary of the Cleveland Engineering Society, has said that there should be a local engineering society wherever a dozen or more engineers reside within such a radius as gives them common interest and convenience in getting together. Such a society may profitably take part in civic affairs, public welfare work and local politics. The Waterloo Technical Society has lately had an active part in formulating a building code for the city of Waterloo. The concerted opinion of 10 or more men, or their joint influence, will be more effective in their community than their separate opinions and influences. Each member's accomplishments will inspire other members.

The engineering profession is on the up-grade. Remember, every boost for the profession is a boost for yourself.

The Sejourne System Wilson Bridge at Lyons, France

On July 14 last the city of Lyons, France, formally placed in service a new bridge over the River Rhone. This structure, named le pont Wilson, in honor of the President of the United States, has several interesting design and construction features which are described in a recent issue of The Engineer, to which we are indebted for the matter that follows.

The Wilson bridge consists of four unequal elliptical arches with a short elliptical approach arch at each end. The total width between the parapets is about 66 ft. and is occupied by a roadway 36 ft. wide and two footways each 15 ft. in width. It is designed on the system developed by M. Séjourné, and applied by him for the first time in the construction of the Adolphus Bridge across the Petrusse at Luxemburg. This system consists briefly of replacing the central portion of the arches regarded longitudinally by a deck of reinforced concrete. In other words, each span consists of two masonry arches, quite independent of each other, except in so far as they rest on the same abutments, with the intervening space filled in with a reinforced concrete deck. This system, in the case of bridges of considerable width, is claimed greatly to economise cost of material, and to facilitate the work of erection. Each span has two arches each 16 ft. 7 in. in width, with a clear gap of 35 ft. 6 in. between them.

The foundations for the bridge are carried to a depth varying between 33 ft. and 39 ft. 6 in. below the level of low water, in conformity with the nature of the river bed. As in the case of other bridges across the Rhone, the material encountered consisted of gravel lying over sand, followed by beds of gravel of increasing coarseness. The maximum pressure on the ground of the river bed is about 11⅓ tons per square foot.

The following table gives the principal dimensions, etc., of the four main arches:

Arch		1.	2.	3.	4.
Intrados	Projected length, ft.	137.7	147.6	160.7	147.6
	Rise, ft.	25.5	29.7	31.3	29.7
	Ratio	0.185	0.200	0.195	0.200
Radius of curve at crown, ft.		147.6	147.6	157.4	147.6
Radius of curve at springings, ft.		11.5	13.3	13.1	13.1
Thickness of arch at crown, ft.		3.3	3.3	3.3	3.3
Thickness of arch at shoulders, ft.		4.8	4.8	5.3	4.8
Pressure per sq. in. at crown, lb.		510	460	470	460
Pressure per sq. in. at shoulders, lb.		563	582	569	582

Contrary to the general rule the arches are not symmetrical in span about the center of the bridge. The current, especially at times of high water, flows deepest towards the left bank, and to provide facilities for navigation the third span had to be made of extra length. In view of the levels of the wharfs on each side of the river, it was impossible to construct a masonry bridge either of three or five arches that would present the required navigation facilities. As the levels referred to were different it was necessary to locate the highest point of the bridge on the axis of the third arch. The second and fourth spans are symmetrical about this axis, while the first is the shortest of the four. The dissymmetry thus introduced is not apparent to the eye.

In making the calculations for the arches a loading of 123 lb. per square foot was assumed. The faced stone for the arches and the greater part of the bridge was obtained from the quarries at Vilette, in the adjacent department of Ain. This stone weighs 166 lb. per cubic foot, and on test showed a crushing strength of 7.3 to 11.3 tons per square inch. The pilasters, the entablature, and the cornices were made from Comblanchian stone weighing about 172 lb. per cubic foot and having a crushing strength of 6 to 7 tons per square inch. The bearing blocks supporting the reinforced concrete deck were formed of stone from Villabois (Ain), having a weight of 165 lb. per cubic foot, and a crushing strength of from 5.4 to 7.3 tons per square inch.

All the stones were worked to shape at the quarries, and arrangements were made at the site of the bridge to reduce the subsequent handling to the lowest possible amount. On arrival at the yards, the stones were lifted by means of an electrically driven traveler on to trucks running on a 60 cm. gage line lying between the traveler rails. On these tracks the stone were taken to the end of a service bridge erected between the two rows of arches. They were then carried out along this service bridge by means of an electrically driven ropeway, and were lifted into their final position by means of an electrically driven traveler running on rails laid one on each side of each row of arches.

The arches were constructed successively from the right to the left bank of the river. The program drawn up covered the erection first of the upstream series of arches, followed by the downstream series, the same centering being employed for both. Strictly speaking, on this plan, centering for three arches only would have been required. In the end, however, largely in order to gain time, the two series of arches were erected simultaneously, so that the re-employment of most of the centering was rendered impossible.

As a prevention against a rise of the river resulting in premature decentering, these boxes were submerged in paraffin wax contained in wooden tubes. The decentering of the arches was carried out 35 days, on the average, after the last joint was made. The settlement which occurred in decentering was as follows:

Arch No.	Decentered	Settlement
1 upstream	Feb. 19, 1915	0.[illegible]94 in.
2 upstream	Mar. 17, 1915	0.[illegible]20 in.
3 upstream	May 14, 1915	0.094 in.
4 upstream	June 19, 1915	0.0[illegible]5 in.
4 downstream	Feb. 1, 1915	0.236 in.
2 downstream	April 2, 1915	0.[illegible] in.
3 downstream	Mar. 28, 1915	0.0[illegible]9 in.
1 downstream	Jul. 1[illegible] 1915	0.0[illegible]8 in.

These figures are below those which were predicted.

The design of the reinforced concrete deck of the bridge is carried out on the Hennibique system. Work upon it was begun on Oct. 9th, 1916, and finished on Oct. 30th, 1917. The deck has a length of about 728½ ft., and a width of some 53½ ft. Its surface measures about 38,970 sq. ft., and its volume 42,373 cu. ft. Approximately 270 tons of steel or iron and 425 tons of Portland cement were used in its construction.

The roadway and footpaths are carried on reinforced concrete beams measuring 5 ft. 7 in. at the center, and 3 ft. 1½ in. at the ends. These beams are formed of a flange measuring 13 in. by 15¾ in. on the top side, and a 12¾ in. by 9⅞ in. flange on the underside, the flanges being united by struts having a section of 12¾ in. by 9⅞ in. each. The spaces between the struts are occupied by partitions about 4 in. thick. The two extremities of each beam rest on low raised facing measuring 19⅝ in. by 27½ in. formed on the top surface of the arches or of the spandrel columns.

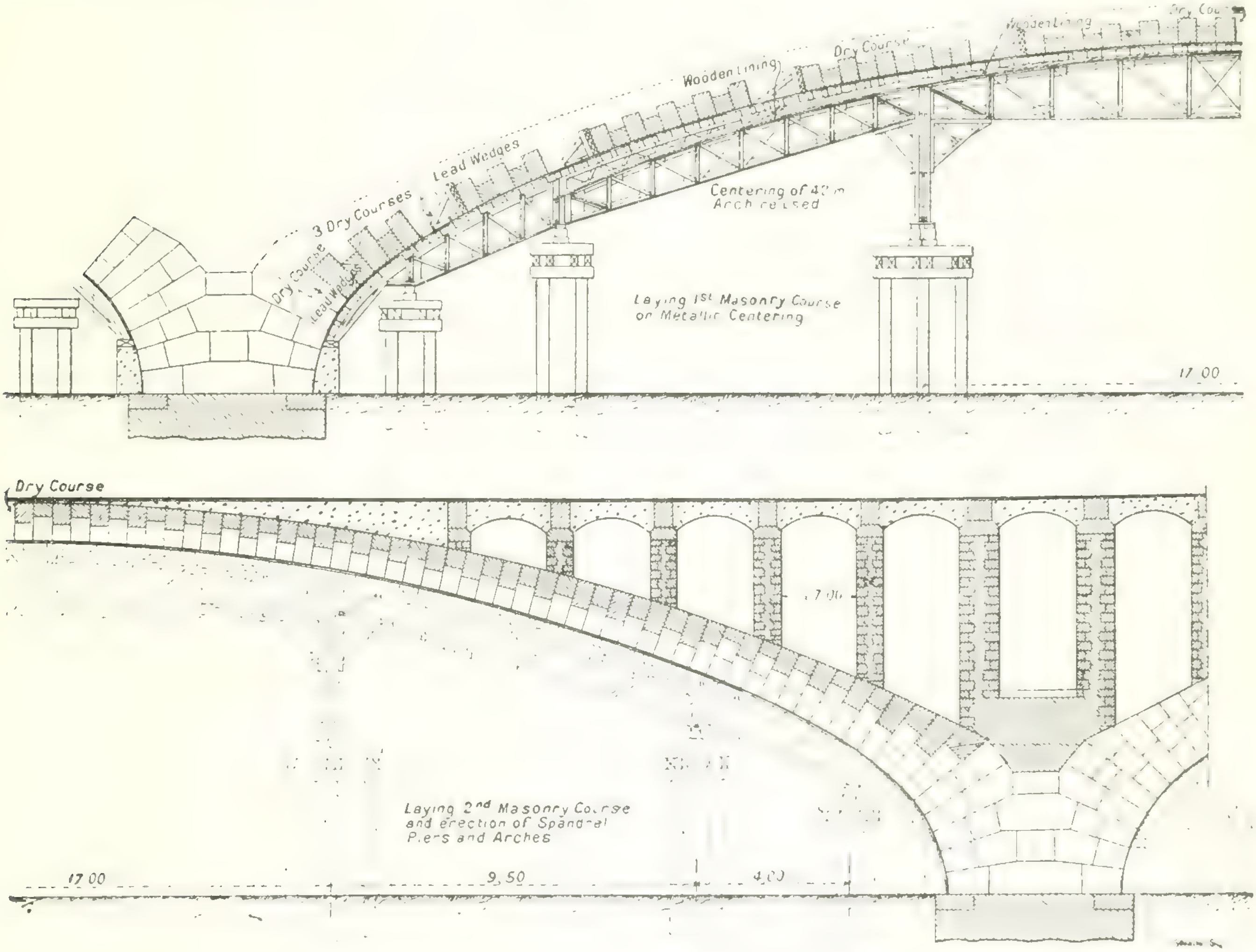
Dry Course
Wooden Lining
Dry Course
Wooden Lining
Lead Wedges
3 Dry Courses
Dry Course
Lead Wedges
Centering of 43 m Arch raised
Laying 1st Masonry Course on Metallic Centering
17.00
Dry Course
17.00
Laying 2nd Masonry Course and erection of Spandrel Piers and Arches
17.00
9.50
4.00

Fig. 1—View Showing Method of Building the Arches.

For various reasons, it was preferred to employ metallic centering instead of wooden. The arrangement, as adopted for the largest arch, is illustrated in Fig. 1. The total weight of steel employed for the centerings was 366 tons. Each of the principal arches, as shown on the same engraving, is composed of three courses of masonry at the springings, and two at the crown. The voussoirs fit into each other after the manner of gear wheel teeth, both in the longitudinal and the transverse direction. The first course was laid down in eight sections supported on angle pieces, the sections being arranged symmetrically and in such a manner as not to cause the centering to suffer any deformation. The joints were filled with mortar rammed in by means of iron beetles. The filling was commenced at the highest joints, the succeeding joints being completed in succession at properly chosen intervals of time.

The centering was supported on boxes containing sand.

[illegible] concrete 6¼ in. [illegible] longitudinals measuring [illegible] apart. The footways are formed [illegible] in. thick carried [illegible] and on a low wall uniting the ends of the [illegible]. A double line of tram[illegible] of the roadway dur[illegible] was made to avoid the return current acting injuriously on the reinforced concrete. The surface of the roadway is formed of creosoted wood blocks, while the footways are asphalted. Under each footway, between the ends of the cross beams and the parapet, a rectangular channel measuring 4 ft. 7 in. by 3 ft. 9 in. is formed, for the reception of water, gas, electricity and telephone mains. Arrangements are made so that these [illegible] for the inspection, etc., of the mains.

The bridge is lighted by ten pairs of 400 cp. electric lights carried on the standards for the overhead wires of the tram[illegible] lamps on separate posts. The [illegible] "half-watt" incandescent type. The mean illumination on the central axis of the bridge is 10.3 candles. The minimum illumination occurs at the center of each bay, and amounts to eight candles, while the maximum occurs at the piers, and is fourteen candles. The ratio of the minimum to the mean illumination, namely, 0.75, is regarded as very satisfactory.

The total cost of the bridge is estimated at about $430,000. The length of the bridge being 745 ft., and the useful width 63½ ft., the cost in round figures is equivalent to $558 per lineal foot, and $8.40 per square foot. These figures are considerably less than the corresponding figures for metallic bridges of recent erection at Lyons, a remarkable result in view of the appreciation in all directions resulting from the war. The bridge was constructed under the direction of M. Chalumeau, chief engineer to the city of Lyons.

Mahoning Valley Engineers' Schedule of Fees

The Mahoning Valley, Ohio, engineers, have a standard fee schedule. The schedule, as given in the 1918 report of the Committee of Standard Fees of the Iowa Engineering Society is as follows:

Per Diem Rate.—Consultation, opinion, testimony, preliminary investigation, reports, and consulting capacity upon design, minimum, $25 per day. (While absent from city, attending court, or similar duties, or traveling, each day of 24 hours, or fraction thereof shall be considered as one day irrespective of the actual time spent on the case. Otherwise seven hours shall constitute one day.) For examination or reports of an extensive nature covering several days, minimum, $15 per day. Engineer in charge of field work, minimum, $10 per day. Assistants, classed as instrumentman of party, minimum, $5 per day. Assistants, classed as rodmen, chainmen, etc., minimum $3.50 per day. Inspector on paving, sewer, etc., minimum, $3.50 per day. Minimum charge for field work, $10. To all the above an additional charge will be made to cover actual expense, including $10. Residence lot, minimum charge, $10.

Office Work.—Calculating, draughting, etc., $10 per day. Minimum charge, $2.50. Minimum charge for one map, $5. Engineer to retain original drawings, but to furnish one print copy to client and if plat is for public record one copy on tracing cloth in addition. Additional copies to be furnished client at cost.

Percentage of Cost.—Engineering and supervision for sewer district or system, or disposal plant, minimum:

Contracts under $3,000, per diem rate. Contracts under $30,000: First $15,000, 8 per cent of estimate. Second $15,000, 7½ per cent of estimate.

For Paving.—Contracts under $3,000, per diem rate. Contracts under $30,000: First $15,000, 7 per cent of cost. Second $15,000, 6½ per cent of cost. Client to pay for one inspector on percentage work.

The above rates are a base for contracts with a reasonable time limit in the contract and all overtime to be based on the per diem rate.

Constructive Criticism of Architects*

By OSCAR WENDEROTH,

Former Supervising Architect of the U. S. Treasury Department.

The present world war is causing many of us to think more deeply about things than we ever have done and undoubtedly will effect more than one revolution in previously accepted methods and systems. I have no hesitation in stating that one of these changes will be to deprive the architect of much of the autocratic authority which he has heretofore possessed.

For a long time I have believed that the architect has had the wrong point of view in considering himself purely as a professional man and in arrogating to himself a position in society beside the recognized professions—such as medicine and the law—and in trying to place himself in much the same category with painters, musicians and sculptors.

The architect's work is not personal in the manner of the work of those with whom he seeks to class himself. When the painter has completed a canvas; when the writer has set down the last word of his manuscript; when the composer has placed the last hieroglyphic on his score, he is finished. It may be, as in the case of the composer, that his ideas must be expressed in another medium than that he used in recording them, but a musical composition is performed directly from the composer's score and the performances may be repeated in all their pristine freshness of inspiration long after the composer himself has "gone west." That, however, is merely a matter of method imposed by the very nature of the art of music.

When the work of an architect reaches the stage attained by a composer upon the completion of a musical score he may be said only to have commenced. Up to that point, the architect's work has been largely intellectual. It has been concerned with the academic solution of the particular problem; with matters of design, with the preparation of highly technical drawings, highly technical specifications, etc. Up to this time, the architect may be said to work much in the manner of the attorney who seeks a legal solution of a given legal problem and then embodies his conclusions in a legal brief. At this stage the lawyer may be said to have completed his work, but not so the architect.

The architect's ideas are expressed conventionally by means of drawings and specifications but they may be translated into terms of building construction only by setting in motion numerous agencies that trade in the elements of building construction—not as matters of art—but purely as matters of business. And the architect must deal with these agencies on a business basis.

Because of this necessity of dealing with business agencies before his ideas may be expressed in physical forms, the position of the architect in the scheme of things differs fundamentally from that of the physician, the attorney, the writer, the dramatist, the poet, the sculptor, the musician.

On the other hand, the architect cannot be allied with the exponents of the various industrial arts. Lighting fixture manufacturers, furniture manufacturers, silver and gold smiths stand on the same plane with architects in matters of design. In fact, some of them produce works that in genuine inspiration, individuality and skill are more really akin to the work of the true artist than is the work of very many of the most eminent architects. But these artificers, cunning and skilful as they are, do not sell a "service"; they market a finished product.

The architect will find his "place in the sun" only when he understands thoroughly the nature of the service he should render to society. More than anything else, his position is that of a trust officer.

A client places in the hands of his architect a sum of money. The architect is asked to expend this sum for the client in the creation of a building in which the client may conduct his business more economically or efficiently, or in which he may live in greater comfort, or out of which he may derive an income, or by means of which the health or convenience of the public may be conserved.

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*From The Architect and Engineer.

It is true that a limited portion of the architect's work is concerned with purely decorative matters—such as the design of monuments, fountains, etc., but even these investments bring in a return.

Save when the architect has the luck to marry a rich wife and so may build a house for himself, he is solely occupied with directing the expenditure of the money of others. This is a serious and sacred responsibility; it is the function the exercise of which differentiates the architect absolutely from the lawyer, the physician and the members of the other so-called "professions" and is the thing that allies him with the trust officer in so far as his relation to society is concerned.

No man in his sober senses would place any part of his own estate, or the estate of another, in the hands of a trust company the officers of which were notorious for iridescent financial dreams but criminally lacking in judgment regarding the value of investments.

No man in his sober senses should place any of his money in the hands of an architect for investment in building construction, if the architect is able only to produce clever and enticing things on paper and lacks the business organization for translating them efficiently into terms of building.

The architect who does not surround himself with a business organization, who does not know business methods, who is unfamiliar with buildings costs, who is not skilled in buying, as the agent of his client, and who does not obtain for his client the best quality of building construction at the proper price is not discharging his whole duty to his client. He is a menace to society and he should be restrained from practising independently.

The autocratic attitude of the architect is undoubtedly due to the fact that for years he has been trained to believe that when he has conceived an academic solution of a problem, everything else is of minor importance. Obsessed with this idea of superiority, the architect assumes a contemptuous attitude towards all matters of business, towards contractors, towards engineers, and may even place but little value upon the technical adequacy of his own working drawings and his own specifications.

That this autocratic attitude brings its own punishment is commencing to become evident. Owners are going to "others who build better, more efficiently and more economically under the name of architectural or engineering contracting firms." This the architect has brought upon himself.

There is much fine architecture produced in this country, and a large proportion of it is done by individuals and firms with enviable reputations—in the "profession." We think of these individuals as acquiring their reputations and their large practices solely through the architectural quality of their work. But if we analyze the situation, we find that such is not the case. The architects who stand highest are as keen "business getters" as is anyone else. They do not advertise directly—yet—and they may avoid unregulated competitions as much as possible, but they seek work by means of personal and social connections to an extent that would make a reputable physician blush with shame. But the architect has been forced to adopt these devious methods of obtaining work because he has thought it necessary to hide behind a thin camouflage of alleged "professionalism," which prevents him from seeking employment openly. When, however, the architect realizes that his service to his client must rest upon a firm foundation of business efficiency he will be able to approach the client from that angle and he will obtain work because of what he can do rather than because of the number of friends he has.

There are architectural organizations that have financial conections and that assist clients in financing building projects. This is an entirely legitimate service for which these organizations are as much entitled to demand fees as are the bond and mortgage houses. But it is looked down upon more or less. Why? Because these organizations use their financial connections as levers to obtain employment for themselves as—architects. They are "playing both ends against the middle"; they are looked upon with suspicion and they are considered as engaged in unethical and reprehensible practices merely because the "professional" standing which the architects of this country are trying vainly to attain for themselves is based upon entirely false premises through ignoring the fundamentally important function of the architect as a business man.

The offices in this country that have great architectural reputations do not exist solely because of the quality of their architectural work. They survive, first, because they are business getters—regardless of their devious methods of obtaining work and, second, because in each such organization there is a "power behind the throne." The "power" is usually an engineer! He has an understanding of, and an apreciation of, matters architectural because he is educated and a—gentleman. This is the chap who prevents the "long-haired" contingent from sending the concern on the rocks. He is looked down upon somewhat because he is engaged in such sordid activities as directing the business end, managing the office at a profit, discussing business matters with clients, checking bids and estimates, directing the specification writing, passing upon engineering and structural matters, adjusting costs with contractors and doing quietly the things that to the client represent the really valuable part of the architect's service.

It is desirable, of course, that the client should appreciate the purely architectural worth of the architect's service, because the future of the "art" side of architecture in this country depends upon the intelligent encouragement of the architect by the client—as a patron—but, after all, the thing that touches the client closest is the manner in which the architect spends his, the client's money, and the value obtained for it.

The business of architecture today is doubtless more complicated than any other activity. The architect's office is a sort of department store, dealing in miscellaneous service instead of in miscellaneous merchandise.

The matter of architectural design is a profession in itself. A knowledge of the theory of design and the experience necessary to apply this knowledge to the solution of actual problems is as much as any one man can master in the short span of a lifetime—and many of us do not proceed very far along this difficult road, at that. But the capable designer—the man whose work can be used—must have a working knowledge of the characteristics of materials. In addition, he is required to be familiar with color in design, with ornament, etc. He must know the industrial arts in order that he may select intelligently the lighting fixtures, the rugs, the furniture, the hangings, etc., that will best compose with his own work.

But these academic matters are not the sum total of the architect's service.

If he succeeds, his organization must be able to obtain business. Somebody must be a salesman, whether he resents being known as such or not. If there is no salesman in the organization, the service of the organization will not be marketed.

In the development of the working drawings and specifications the architect is assisted by men who, with the exception of a very few, are chosen because their mental bias does not incline them towards architectural design, per se. These are the "job captains" who must have executive ability and must know how all kinds of materials used in building construction are combined, in order that they may be intelligently indicated on the drawings, and these are the men who must know all about qualities of materials, sources of supply, etc., in order that they may include in the specifications the information that may not be placed on drawings.

Then there is the engineering contribution, none of which has anything whatever to do with considerations of architectural design. This work calls for a very high order of skill and intelligence, and let it be noted here that the "big" engineers display in their work the same qualities of imagination—the same creative instincts—that make for distinction in the work of the "big" architects.

Then there are all the dealings with contractors. I understand that there are some two hundred trades that, in one way or another, contribute to the various classes of building construction for which the architect prepares designs. To each one of these businesses a man will devote the study of a lifetime and then only become versed in one phase of [illegible] [illegible] [illegible] [illegible] [illegible] familiarity with all of [illegible] [illegible].

The [illegible] knowledge of the [illegible] of building materials and building products does not in itself give a man the ability to deal successfully with building contractors and the manufacturers of building products. That is a matter of [illegible] and [illegible] knowledge of business relations. It is an executive rather than a technical function.

The direction of the construction of a building "in the [illegible]" [illegible] [illegible] [illegible] [illegible], [illegible] for the passing upon carving, colors, textures, etc., and this is done by most busy architects in the office many of them, in fact, never actually see the buildings that are erected at any considerable distance from their offices. Capable superintendence is a [illegible] in itself. A [illegible] [illegible] be a good job captain, may write a fine specification or may direct the business details of a considerable operation and yet may not be able, for the life of him, to tell whether a certain batch of concrete is or is not being mixed properly.

The architect does considerable bookkeeping in connection [illegible] [illegible] [illegible] [illegible] with payments to contractors, with extras, credits, etc., and if he is to keep things straight [illegible] [illegible] [illegible] be [illegible] as carefully as it is in any business office.

[illegible] [illegible] of correspondence, adjusting controversies, making final settlements, dealings with clients, etc., etc., the architect discharges a business function that, in essence, is [illegible] [illegible] different from the business function of the despised contractor—except that the latter probably does these things much more intelligently and effectively.

There is [illegible] [illegible] [illegible] living and there never will be a man born who, of himself, can do all these things. I do not believe that any architect ever tried to persuade himself that he could do all of them. The trouble is that he has been [illegible] to think of himself as a professional man doing a personal thing. The result is that he places an importance upon the particular element of his service in which he has skill and considers everything else as subordinate and immaterial.

If it is true that no living being could render with uniform skill all the kinds of service that, together, make up the contribution of the architect, it necessarily follows that the complete service may only be offered by a number of men working together, each one contributing an important and necessary, but different, element.

Such a group must be made up of a business getter, a master of architectural design, a structural engineer, a mechanical engineer (heating, ventilating, sanitation), an electrical engineer, a business administrator and a technical director. An organization thus constituted is a business organization; by no stretch of the imagination could it be considered as a professional organization. I speak now of an organization in which each one of the elements of the architect's service is given its proper relative weight and is directed by a man who, in his particular thing, is as skilled as is "the architect." That the architect may, and usually does, employ outside practitioners to supply him the necessary engineering skill does not affect the main argument which is that a properly balanced architectural organization must be a business organization; it cannot be a personal and professional one.

The reason that the architect must surround himself with men of business and executive ability is that the great bulk of his service to his client and to the community is a business service; in fact, architectural design, per se, is really the smallest element in the architect's service, although most conspicuous.

That architectural design is the least weighty element in the architect's service is proved by the number of architects in this country who build up large businesses without using it at all. These men do everything else that the complete architectural organization should furnish and they succeed because of the value to their clients of the things that they actually do furnish.

The man who is a business getter, who has an efficient organization, who handles his practice as a "business proposition," who administers the work of construction adequately, who is a capable buyer for his client and who keeps measur[illegible] [illegible] [illegible] [illegible] [illegible] [illegible]" build up a large and well paying "practice" with the least possible expenditure of thought on matters of academic design. And such a man earns all of the considerable sums he is paid because he "delivers" goods that have value.

On the other hand, a man may have great talent and may be highly trained in matters of pure design and may—starve in a garret because he has neither the necessary business qualities for success nor the sense to connect with the right people.

After all, it is success we all are aiming for. What good does it do a man to have great talent if he is given no opportunities for exercising it? And in architecture, above everything else, the opportunities for doing big and interesting things depend almost entirely upon "getting the business."

The architect today who is trying to impress his client with the idea that he, the architect, is engaged in personal and professional work is constantly playing a heart-breaking game of bluff. Instead of telling the client frankly that he is but one—though perhaps the principal—member of an organization that is offering the client a very complete service, he must try to impress the client with the belief that he is the "whole thing." So he keeps his associates in the background, for to admit that their contribution was as essential as his, would destroy the air of professionalism and of personal service that a mistaken theory requires him to try and maintain. So he bluffs and bluffs, making wild guesses now and then, until finally he is found out.

One cannot conceive of a man engaged in true professional work having about him an organization such as is absolutely necessary to the architect if the latter is to discharge fully his obligation to his client and to the community. No professional man would undertake to do a number of things in most of which he had no skill. Such a professional man would be set down immediately as a charlatan because he would be operating a business under the guise of a profession.

Plenty of instances of similarity may be found between the organization of the architect's ideal office and the organization of business institutions, but none whatever can be discerned between the organization of such an office and a professional establishment. The reason, to reiterate, is that the architect's relation to society is that of a business man and not that of the professions.

Consider the ideal office. It is organized somewhat after the manner of a corporation engaged in, say, the manufacture of motor cars. There is the business getting department (the advertising department), which may be the function of some one member, or of more than one member, of the organization; there is the architectural designing department (which corresponds to the laboratory of the motive engineer); there is the engineering department (which corresponds to the machine shop); there is the superintending department (which corresponds to the assembling shop); there is the business manager's department (which corresponds to the sales department) and there is the executive department.

In the executive department the architect's organization resembles the scheme of organization of the professional man. But, then, every activity must have a head—a directing impulse—whether it is a doctor's office, an architect's office, a motor factory or a Governmental establishment. Even so, the architect's office may more closely resemble the motor factory than the doctor's office. The latter must at least be his own executive while in the architect's office the real "boss" may be the "power behind the throne" and not the titular head of the organization.

There is another point in which the architect's organization resembles a business organization and not that of a professional man. One, or two, or all, of the members of an architectural firm may die and the business be continued under their name and without loss in so-called "professional" standing. What would happen if, on the death of a physician, his office assistant—himself a graduate physician—should calmly "succeed" to the dead man's "business," continue to use the dead man's name and in the name of the dead man write prescriptions? That is inconceivable in a profession, because a profession is a personal thing; a professional practice cannot leave behind it a "good-will" that can be traded in. But this is possible and legitimate in a business, and that it is known and used in the "profession" of architecture shows that notwithstanding their claim to being "professional men," architects do realize the purely business aspects of their relation to affairs.

Can anyone conceive of several physicians being known as "Dr. Smith & Co." save as compounders of nostrums? Can anyone imagine giving his legal business to, say, "Brown, Jones, Robinson, Tompkins & Co."? Did anyone ever hear of a symphony being composed by "Beethoven, Haydn & Company"? Yet such firm appellations are frequent in the so-called architectural "profession." In fact, the head of the firm of D. H. Burnham & Co. became president of the American Institute of Architects. Mr. Burnham, by the way, had the right idea. He gathered about him men skilled each in doing one of the many things required of an architect, while he, himself, did the one thing that he knew how to do best. Whether accurately or not, he was quoted as saying that he was a business man who had some knowledge of building.

The architect's ideal office, organized as I have described, would raise the architectural standard in this country immeasurably. In such an office, the department of architectural design would have its own recognized place and matters purely architectural would be given due weight. The chief of design would probably not be concerned with hustling for business, nor with specification writing, nor with matters of business administration—all things foreign to the designing "temperament." All these things would be looked after by men to whom that sort of work is congenial. Each man would become highly skilled in his particular subject and the result achieved for the client would be a fusing of the best skill and judgment of the several department heads. Better architecture would be possible for two reasons. First, the chief of design would be left free to develop matters of design to the extent of his ability, and second, his authority as chief of design would be respected because one of the elements in the reputation of the organization would be the character of its output as architecture. All of that would be controlled solely according to the "policy" of the organization. At the inception of a project, there would be a "cabinet" meeting at which each department head would see to it that the thing for which he was to become personally responsible later was given its proper share of consideration. The result would be something that would represent to the client the best judgment of several trained men. In this way the client would be protected from having foisted on him things that would be horribly expensive to construct, things that were not adapted to his requirements, things that would inevitably cost more than his stated limit or things that merely expressed a fit of indigestion on the part of the designer.

Such an organization would quickly put out of business the other type of organization to which I have referred—the organization that is effective as a business unit but produces work inferior architecturally. The ideal organization would do as effectively everything that the other kind of organization is doing and in addition would produce good architecture because a reputation for excellence in design would be as much one of its assets as good business administration is the sole asset of the other type of organization.

But it may be objected that this scheme of organization would impose such a restraint upon the creative impulse of the designer as virtually to destroy all inspiration.

Any designer who is able to work only when his fancy is given free rein is an unsafe person and should be restrained —in an asylum. Much of the discredit that has been brought upon the "profession" of architecture is due to the wild schemes of architects who will not consider the wishes of clients, who ignore limitations of cost and who think they are not giving play to their creative instincts unless they are doing something thoroughly irresponsible.

A business organization that is engaged in rendering a highly articulated service naturally forms itself into a corporation. In fact, this is required by law of certain types of business organizations—banks and trust companies, for instance.

The ideal organization for an architect should be a corporation. This form tends to stability. Each head of a department is a stockholder and the interests of the corporation are his interests also. Such an organization tends to inspire confidence in the mind of the client.

An architect may, of course, gather around him men who work with him congenially and who add to his contribution the things necessary to the complete service to which the client is entitled. The minor employes, of course, go and come, but when all the principals except the head hold positions that are subject to similar mutations there necessarily exists an element of weakness in the organization. An organization in which the directing personnel changes frequently can never become well knit and effective. It is only when the directing heads are part owners and have a say in the business policy and management—to the extent of their ability and have, also, a say in the important matter of hiring and firing that they become wedded to the particular business and give it their best efforts.

These are the signs of the times. If the architects are to hold their own they must understand that before everything else they must be effective business men; that their organizations must be founded upon business principles; that it does not suffice to produce fine "paper architecture" and to ignore or subordinate all the other elements in the service to which the client is justly entitled; that they must cease to worship the fetish of "professionalism," and they must cease to pose as self-contained individuals rendering an exclusive personal service.

The published statement that the clients are commencing to go to the "others who build better, more efficiently and more economically under the name of architectural and engineering contracting firms," may be true. That these "others" have found a profitable field is because they are capable and shrewd business men. And because they are capable and shrewd, they will fortify themselves against the criticisms and jealousy of the "legitimate" architects by doing as good architectural work as the latter. For the "others" may employ skilled designers merely by making the working surroundings attractive and they will be smart enough to do that little thing. And at that they will merely be doing what many architects are doing anyway—except that they will not allow the tail to wag the dog. They realize that it would hurt their business reputations to be classed as architects.

The only way the architects can meet this new situation and save themselves is to change their point of view, reorganize as business institutions and by building better, more economicaly and more efficiently try to meet the growing competition of the "architectural and engineering contracting firms" that already are taking work away from them.

Work of the U. S. Housing Corporation

The United States Housing Corporation on Nov. 1st, 1918, had already under construction or ready to let, 18,747 permanent buildings, to house 23,319 families; 1,771 ready-cut buildings, to house as many families, and 300 buildings to house approximately 24,190 workers without their families. It has established municipal utility improvements costing over $13,000,000, has loaned $6,500,000 to public utility corporations for necessary extensions and improvements, and when the close of the war checked its activities was purchasing and delivering building and construction material at the rate of $1,000,000 a day. The engineering work alone called for 70,000 freight cars to move its materials. In addition to this through the Requirements division it has interested private capital to the extent of building 13,000 houses at a cost of $43,000,000 under restriction imposed by the corporation, such as limiting rentals, etc.

New Business of Fabricating Shops in 1918 Was 56 Per Cent of Capacity.—The records of the Bridge Builders & Structural Society as collected by its secretary, show that during the month of December, 1918, 29 per cent of the entire capacity of the bridge and structural shops of the country was contracted for. During the entire year of 1918 the new business placed amounted to 56 per cent of capacity.

Method and Formulas for Dimensioning Wing Wall Abutments

By HENRY L. PARKER

[illegible] Me.

Since the top of the wing wall in a wing abutment is made to parallel the slope of the fill adjacent, the dimensions of the abutment [illegible] upon the angle made by the horizontal projection of the top of the back of the wing wall with a normal to the centerline of the roadbed. This angle is rarely given upon a working drawing since the constructor starts with dimensioned neat lines and works out the results indirectly.

It is also desirable to use such angles for the neat lines as are readily laid out upon the ground preferably one that will work out in even inches per foot using the face line of the abutment extended as a reference line.

The following formulas and methods permit the desired values to be readily calculated. No special form is recommended but should be varied according to the conditions to be met, the values that control the layout being selected accordingly. The notation follows:

Let H = maximum height of wing above footing.

h = minimum height of wing above footing.

Δ = angle made by the horizontal projection of the back of the wing with the face of the abutment.

S = slope ratio of fill normal to the g = $\frac{a}{b}$ Fig. 1.

χ = batter in feet per foot on the face of the wing.

φ = angle between the horizontal projection of the face of the wing at the top with the neat line caused by the batter χ.

Y = batter in feet per foot on the back of the wing.

Θ = angle caused by reason of the batter y.

Z = angle of skew.

B° = angle of cut-off of the end of the wing with a line normal to the face of the abutment.

L = length of wing for height = H.

l = length of wing for height = h.

Figure 1 will show the significance of the above notation probably clearer than the description given.

$$L = SH \sec(\Delta \pm Z) \quad \ldots\ldots (1)$$

For skew crossings the sign at Z will be plus for one side and minus for the other.

When Z = 0 L = SH sec Δ

$$l = S(H - h) \sec(\Delta \pm Z) \quad \ldots\ldots (2)$$

The expression (Δ ± Z) representing the angle made by the line of the back of the wall with a normal to the center line of the road bed.

Having the angle (Δ ± φ ± Z) or angle made by the neat line on the face of the wing with a normal to the center line of the road bed, the rate of batter on the face of the wing χ, to determine the angle of batter φ

$$\tan\phi = \frac{\chi\cos(\Delta \pm \phi \pm Z)}{S - \chi\sin(\Delta \pm \phi \pm Z)} \quad \ldots\ldots (3)$$

For square crossings Z = 0 and

$$\tan\phi = \frac{\chi\cos(\Delta + \phi)}{S - \chi\sin(\Delta + \phi)}$$

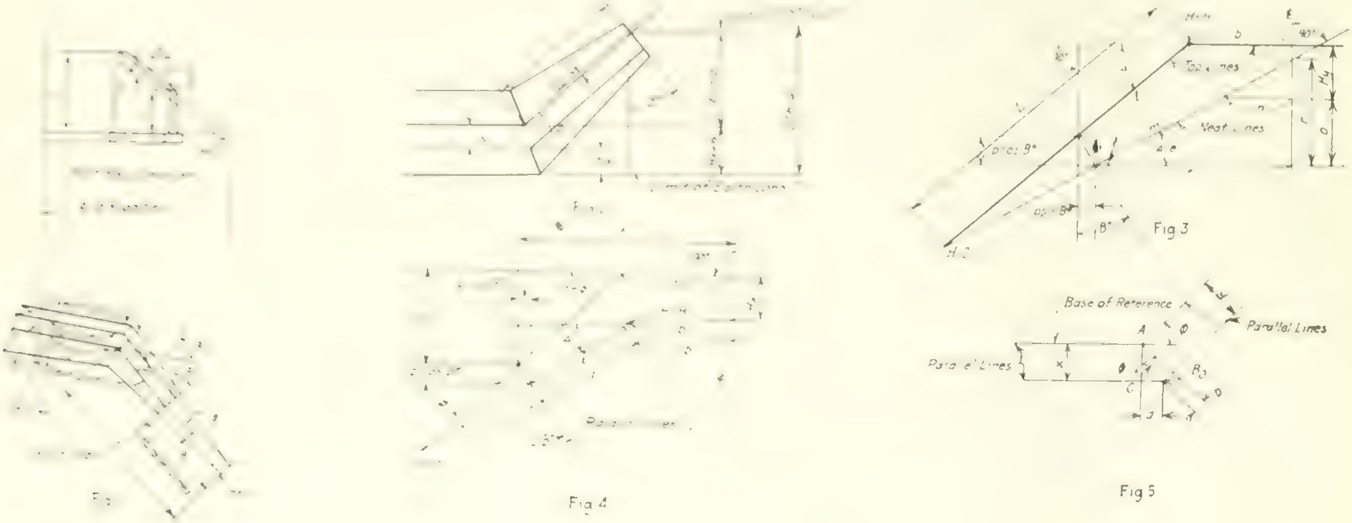
The value of (Δ ± Z) may then be determined and the value of L and l found from (1) and (2).

A check may be had by writing

$$\sin\phi = \frac{\chi}{S\sec(\Delta \pm Z)} \quad \ldots\ldots (4)$$

Should the value of φ be determined by the conditions of layout the value of χ corresponding to the value of φ used may be determined by solving (3) or (4) for χ.

The foregoing formulas involving φ assume that the wing is of uniform width at the top as is usual in most designs.



Figs. 1 to 5.

However, should the lines not be parallel, the angle in the brackets must be modified to take the divergence into account. In any case the angle desired is that made by the reference line to a normal to the center line of the roadbed.

If the batter "y" is given

$$\sin\theta = \frac{y}{S\sec(\Delta \pm Z} \quad \ldots\ldots (5)$$

If Θ is given

$$y = S\sin\theta\sec(\Delta \pm Z) \quad \ldots\ldots (6)$$

The angles Δ, φ and Θ having been determined by the conditions of the layout, the next step is to decide on the proper value of h so that the earth will in falling around the end of the wing offer no encroachment on the opening required to be maintained.

The clearance desired will depend upon the characteristics of each individual crossing, being effected by alignment and velocity of the stream, liability to scour, elevation and frequency of high water, depth of footing below the natural surface and the slope of the ground away from the stream.

The angles used at each corner should be such as to render the structure permanent and to preclude any liability of the water getting in back of the structure and at the same time paying due regard to economy of the entire crossing including both sub and superstructure.

For short span bridges and culverts, a common assumption is that the cone of earth shall, in falling around the end of the wing, extend to the neat line on the face of the main wall of the abutment extended at the plane of the top of the footing.

In addition to the notation already given

Let w = width of abutment at the elevation of the top of the wing.

d = distance below the top of the wing that the earth is assumed to be measured vertically.

Figure 2 shows the significance of the above assumption

Then $$S(h - d) = \frac{S(H - h)\sin\Delta}{\cos(\Delta \pm Z)} = dy\sec(\Delta - B^\circ)\cos B^\circ + w + H\chi \quad (7)$$

If Z be made = 0 as in square crossings and Δ = B

$$S(h - d) = S(H - h)\tan\Delta + dy\cos\Delta + w + H\chi$$

Values for S, H, Δ, d, z, y, χ, w and B° are to be substituted in the formula and solved for h.

In preparing a number of similar designs it is convenient to find h in terms of H thus simplifying the calculations for h and l.

Neglecting the effect of d, χ, y, w and B° as small (7) may be written—

$$h = \frac{(H - h)\sin\Delta}{\cos(\Delta \pm Z)} \quad (8)$$

showing that the end height is independent of the rate of slope. For square crossings Z = 0

and $$h = \frac{H\tan\Delta}{1 + \tan\Delta} \quad (9)$$

In comparing results given by (7) and (8) it will be found that the latter gives slightly smaller values for h and thereby requires a slightly longer wing than the former.

In case greater or less clearance is desired due to depth of footing, etc., such additional clearance or deduction should be added or subtracted from the right hand member of (7) and the resulting expression solved for h.

The work remaining to be done is to calculate the various lengths required. The following will prove to be satisfactory in use and can be easily extended to cover any desired layout.

Figure 3 shows the work necessary to compute the back lines. In the figures the values of b and l are presupposed to be determined by road-bed and crossing considerations and are used as a base for the rest of the computation.

p can be calculated from the triangle to the left of the figure.

When B = Δ $p = (L - l)\tan\theta$ .... (10)

L and l are calculated from (1) and (2).

$t = b + l\cos\Delta + p\sin B$ .... (11)

$o = l\sin\Delta + p\cos B^\circ + Hy$ .... (12)

$m = o\ \mathrm{cosec}\ (\Delta - \theta)$ .... (13)

$r = t\tan(\Delta - \theta)$ .... (14)

$n = (r - o)\cot(\Delta - \theta)$ .... (15)

$n = t - m\cos(\Delta - \theta)$ .... (16)

If χ and y are expressed in inches per foot, 12 should be used as a denominator for all expressions involving χ and y, since they are herein expressed in feet per foot.

When batters on main and wing are equal

$$n = b + Hy\tan\frac{(\Delta - \theta)}{2} \quad (17)$$

Since the angle of batter θ is usually rounded off to the nearest minute and as the intersection angle of the neat lines is usually rather acute so that a small angular change represents a rather large difference in the measurement (17) should be used only where the rate of batter on the back of the wing and mainwall are absolutely equal and the value of θ used to the nearest second of arc.

Figure 4 shows calculations necessary for the front lines the values of b′ and l′ being used as a base and calculated from values previously used for b and l in calculating the back lines.

Note that in the following the top lines of the wing are assumed to be parallel. If l′ is not parallel to l then the values and Δ and (Δ + φ) should be modified to show the correct angle indicated in the figure.

As before p′ is calculated from the triangle to the left of the figure.

When B° = Δ then $p' = (L - l)\tan\phi$.

and l′ = l + a constant depending on the width of the wing, the width of the abutment at the top and the value of Δ.

The value of b′ will likewise depend on the same data and the previously assigned value of b.

$t' = b' + l'\cos\Delta + p'\sin B$ .... (18)

$o' = l'\sin\Delta + H\chi + p'\cos B$ .... (19)

$m' = o'\ \mathrm{cosec}\ (\Delta + \phi)$ .... (20)

$n' = t' - m'\cos(\Delta + \phi)$ .... (21)

For equal rates of batter χ on the wing and main wall

$$n' = b' + H\chi\tan\frac{(\Delta + \phi)}{2} \quad (22)$$

The dimensions of the footing lines may be calculated in like manner if desired, however an excellent method is to apply a correction to the length of the neat lines, the correction depending upon the offsets and the angle of intersection. See 23-26.

By considering the reference line as normal to the central portion of the abutment after b and l have been determined no difficulty will be encountered in applying the methods and formulas to skew abutment problems.

In order that the top lines of the wing shall be at the same level if a section be taken normal to the center line of the wing, it is necessary that the line marking the beginning of the slope and the direction of the cut-off on the end of the wing shall be parallel. This is indicated in Fig. 4.

For this reason the front part of the wing must be carried level until at a point on a line opposite the point where the slope commences on the back, thus introducing the constant referred to in the data for Fig. 4.

If, in abutments of this type, the horizontal projection of the top lines of the wall are kept straight, a swing is called for in the neat and wing footing lines. However, it is simpler and the effect of this feature is minimized if the neat line is maintained as a straight line and the swing thrown in the top lines of the wing. The effect being that the wall is thickened a fraction of an inch at its junction with the main wall where extra strength is needed. If the swing is thrown in the footing for moderate heights and a reasonable batter the swing in the footing will amount to several inches and render the work harder to lay out upon the ground.

Where the wing is carried out level for some 5 or 6 ft. to protect the approach and then allowed to take the slope of the fill it would seem the better practice to keep the outer neat line sraight and allow the top lines to be controlled by the rate of batter used on the face. To assist in finding the corrections to be applied to the lengths of the neat lines, determining constants, etc., referred to, the following formulas are given. Fig. 5.

The following notation apply as shown in Fig. 5:

$a = [(y\sec\phi) - \chi]\cot\phi$ .... (23)

$b = [(\chi\sec\phi) - y]\cot\phi$ .... (24)

showing that when χ and y are equal "a" and "b" are also equal and the line AO bisects the angle BAC = φ.

Or as probably more convenient for use

$$a = \frac{y - \chi\cos\phi}{\sin\phi} \quad (25)$$

$$b = \frac{\chi - y\cos\phi}{\sin\phi} \quad (26)$$

The formulas are perfectly general and in case the sign of a or b should work out negative it should be taken to mean that the correction so found should be subtracted from the known lengths rather than added as in case of a positive sign.

In some designs the wing is joined to the main wall by means of a curve tangent to the plane of the top of the wing and to the vertical of the junction point.

The horizontal projection of this portion of the wall is also curved but for radii and batters that are practicable the effect is not noticeable.

The angle between the horizontal and the slope of the top of the wall is given by

$$\cot Q = \frac{\cos(\Delta \pm Z)}{S} \quad (27)$$

where Q is the angle between the horizontal and the plane of the top of the wing.

The central angle for the arc then is 90° − Q.

A tangent distance may then be selected that conforms to the value of [illegible] in connection with the width of the road bed and the values of the radius of curvature determined for the [illegible] adopted.

The problem is then one of solving with a straight [illegible] as required by the above mentioned tangent distance.

Abutment layouts are varied greatly and different considerations are sometimes used than those specially noted. These considerations, however, affect the values of A and Q only, so it is believed that the methods given can be applied to the majority of cases arising in practice with but slight modification to cover extraordinary features.

Daylight vs. Sunlight in Sawtooth-Roof Construction*

By W. S. Brown

[illegible] F. P. Sheldon & Son, Providence, R. I.

[illegible] of daylight in sawtooth buildings is obtained by placing the sawteeth so that the glass or lighting area faces the northern sky; sufficient intensity being dependent, among other things, upon the size and slope of the lighting area. Evenness of distribution is procured by properly apportioning the lighting areas. The amount of direct sunlight admitted daily, the time of its admission, and its duration are evidently dependent upon three considerations, the last two of which may be varied within certain practical limits. They are:

a Day of the year, determining as it does the sun's path across the sky;

b Direction in which the lighting area faces as regards points of the compass;

c Slope of the lighting area.

For a given lighting area, a variation in its slope is accompanied by a very appreciable change in the amount of daylight admitted. That is, as the pitch of the lighting area is made steeper, the amount and duration of direct sunlight entering the building is lessened, but only at the expense of the general illumination. Conversely, as the slope of the lighting area is decreased, the intensity of daylight is correspondingly increased, but there also is concurrent therewith a greater amount and duration of direct sunlight. The question then becomes: How steep should this slope be? What is the proper balance between the two contending requirements of little sunlight and much daylight? Also at what time of day will direct solar rays fall upon the working plane, in what locations and volume, and for how long a period?

Naturally, no general answer can be given, but each individual problem should be worked out only after careful study has been made of the particular conditions and requirements which have to be met, not excluding first cost. In the Southern States, for example, the tendency is to adopt a more nearly vertical lighting area than in the northern part of the United States or Canada, on account of the greater altitude of the sun and its intense heat. Occasionally it has been found advantageous to so locate machinery as to avoid any direct sunlight during the working hours.

With a view, therefore, to clearing up such questions as these, the writer's firm, F. P. Sheldon & Son, undertook to work out, in connection with what empirical data they already had, a rational method of design for sawtooth-roof construction.

The subject is necessarily divided into two closely related parts, the first concerning direct sunlight, its amount, time of admission, duration, and location on the working plane; the second relating to intensity of daylight upon the working plane.

Part 1. Orientation of Sawtooth Buildings and Slope of the Lighting Area as Related to Requirements of Least Direct Sunlight.—In the practical problem of the sawtooth roof, the effective slope or vertical angle of the lighting area, on account of projecting jets, gutters, and sash rails, and the interference of roof rafters, etc., is greater than the pitch of the glass itself; this often amounts to as much as 7 or 10°. Similarly the horizontal angle or bearing of the lighting area with respect to the sun's rays may be greater or less than the nominal angle on account of projecting vertical sash bars, etc. This difference often amounts to as much as 5 or 8°.

The position of the sun at any given time depends upon the latitude of the place, time of day, and calendar date, and may be obtained from standard altitude and azimuth tables. Knowing these, the time of admission and duration of direct sunlight for any day of the year may be calculated as follows:

In Fig. 1, let the plane determined by the three points, A, C and D, represent the lighting-area plane, and let points A, B and E define a plane parallel with the horizon. These two planes intersect in line AF. The acute angle v is then the effective slope or vertical angle of the lighting-area plane.

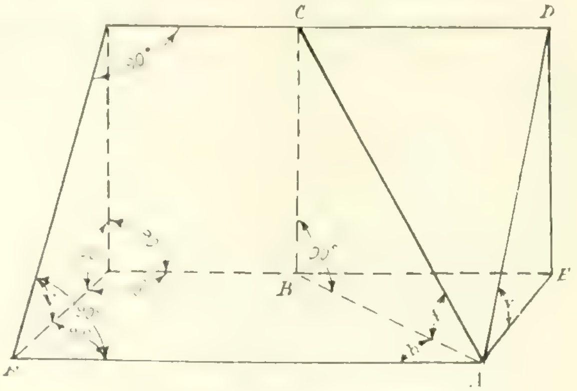


Fig. 1—Path of Direct Sunlight.

Also let line AB represent the horizontal direction or bearing of the sun with respect to the building at any assumed calendar date and time. That is, angle h is the difference between the sun's true bearing or azimuth and the true corrected bearing or azimuth of the lighting-area ridges, each azimuth being read easterly or westerly from north, according to whether morning or afternoon conditions are being computed.

Now pass plane ABC through AB perpendicular to plane ABE cutting the lighting-area plane ACD in line CD. By construction this plane also contains the sun's altitude line through point A. Consequently, it is evident that if vertical angle x is greater than the altitude of the sun, a condition of total shade exists within the building at the given time. And contrariwise, if x is less than the solar altitude, the sun is in front of the plane of the lighting area and some direct sunlight is entering the building.

Now, to find x in terms of v and h (see Fig. 1),

$$AE = ED \cot v$$

and

$$AB = ED \cot x$$

and

$$\cos(90 - h) = \frac{AE}{AB}.$$

Substituting in the last equation the values of AE and AB,

$$\cos(90 - h) = \frac{\cot v}{\cot x}$$

whence,

$$\sin h = \frac{\cot v}{\cot x}$$

and

$$\tan x = \sin h \tan v \quad \ldots\ldots\ldots\ldots(1)$$

From the above equation exact information may be obtained as to the time of admission of direct sunlight and the number of hours of its duration. The solution of a numerical example will illustrate the method of procedure.

Numerical Example, Sunlight Conditions.—Given a sawtooth building located in north latitude 36° Orientation of building is such that azimuth of sawtooth ridges = 99° 08′ E. Angle of glass = 73°. Required to find sunlight conditions on June 10 (sun's declination 23° N.).

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*[illegible] presented at the annual meeting, New [illegible] of The American Society of Mechanical [illegible]

By inspection, according to azimuth tables, sunlight will enter the building from sunrise until at least 9:20 a. m. apparent time, because the sun's azimuth up to that time is less than that of the sawtooth ridges. The method now consists in finding by trial at what time the sunlight entirely disappears from the building.

Assume 10:20 a. m., at which apparent time, according to the tables, the sun's azimuth = 114° 08′ E., and its altitude 64° 46′. Now, v = 73° plus a correction for projecting jets, gutters, etc., as previously explained. (This may be found from detailed section of building and in this case will be assumed as 7°. Then v = 73° + 7° = 80°.) Applying the correction as explained above,

$$h = 114^\circ\,08' - (90^\circ\,08' - 5^\circ) = 20^\circ.$$

Entering Equation (1),

$$\tan x = \sin 20^\circ \ \mathrm{ton}\ 80^\circ.$$

whence

$$x = 62^\circ\,43'.$$

Since at this time the solar altitude (64° 46′) is greater than x, a small angle of sunlight is entering the building The above process may be repeated with a slightly greater assumed value of h, with the result that within a few minutes all direct sunlight will be found to be entirely excluded from the building.

To obtain afternoon conditions, the operation should be further continued until such time as sunlight is found to re-enter as follows:

In this case, instead of assuming the time, and computing h, the reverse method will be pursued and, as a further short cut, it may be reasoned that since the lighting area faces slightly toward the east (that is, N. 9° 8′ E.), h at the transition period will be less than in the morning.

The westerly azimuth of the sawtooth ridges is now used for reference with the tables and equals 90° 0′ — 9° 8′ = 80° 52′. Try h = 6°, at which time the sun's azimuth becomes (80° 52′ — 5°) + 6° = 81° 52′, the apparent time being, from the tables 4:34 p. m., and the sun's altitude being from the tables 30° 10′. Entering Equation (1),

$$\tan x = \sin 6^\circ \tan 80^\circ$$

whence

$$x = 30^\circ\,41'.$$

Since x is 0° 31′ greater than the solar altitude, it is evident that no direct sunlight is entering. However, the angular difference is very slight, and if the computations were carried on a step further, sunlight would be found to come in approximately five minutes later.

In this case, then, on June 10 a condition of total shade exists within the building from approximately 9:20 a. m. until 4:34 p. m., apparent time. Where the apparent time is different from standard time, the proper allowance should, of course, be made. Furthermore, an additional correction must be applied in places where the daylight-saving plan is in effect.

Generally it will be found advisable to solve a given problem for at least two sets of conditions, that of the longest day of the year (June 21, declination, 23½° N.) and the average day of the year (March 21 and September 23, declination, 0°).

In the example above, it will be noted that the duration of total afternoon shade is 4 hr. and 34 min. and is considerably greater than the duration of morning shade, which is only 2 hours and 40 minutes. This is due to facing the lighting area slightly (9° 8′) toward the east, and suggests quite a range of possibilities as regards orientation.

By applying the principles of descriptive geometry, the amount and location of direct sunlight at any given time may be obtained, if desired, by finding the lines in which the solar rays through the top and bottom limits of the lighting area intersect the working plane—the direction of these rays being taken from altitude and azimuth tables. It may also in this case be necessary to include the effect of side walls, division walls, etc.

Table I gives different values of x for assumed values of h as applied in the second method of the example given above. Its use makes unnecessary any reference to trigonometrical tables, unless closer results are desired, for angles not given.

Part 2. The Relative Intensity of Daylight Received from the Northern Sky as Influenced by the Size and Slope of the Sawtooth Lighting Area.—By essence, Part 2 lends itself to exact mathematical solution. This is not the case, however, with Part 2, for which the answer is not to be found so precisely on account of the necessity of introducing certain more or less arbitrary and variable factors. It should, therefore, be applied only with discrimination and strict regard for its practical limitations.

The total amount of diffused daylight entering a building through sawtooth sash and made available for use (direct sunlight being excluded) may be analyzed as consisting of:

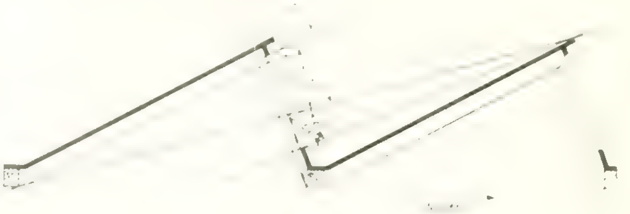

Fig 2

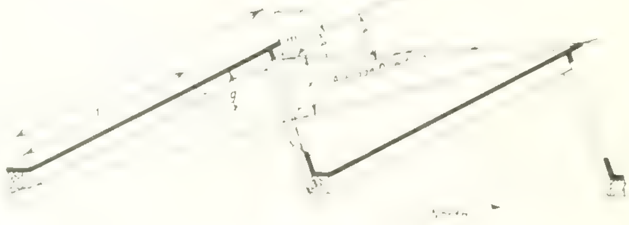

Fig 3

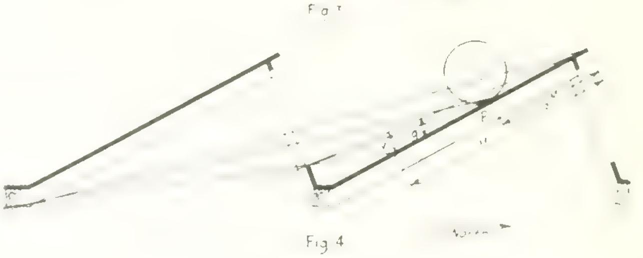

Fig 4

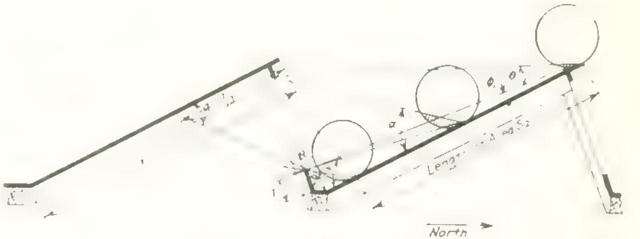

Fig 5

Fig. 2—Area of Direct Skylight Admission. Fig. 3—Path of Skylight Reflected From Ceiling. Fig. 4—Sunlight and Skylight Reflected From Roof Top. Fig. 5—Entrance of Sunlight and Skylight by Double Reflection.

d = light from sky directly incident upon the working plane;

rd = light from sky directly incident upon the underside or ceiling of sawtooth roof and thence being diffusely reflected to room below (one reflection);

r_1c = combined light from sun and sky, diffusely reflected from upper outdoor surface of adjacent sawtooth roof directly to room below (one reflection);

r_2c = combined light from sun and sky, diffusely reflected from the upper outdoor surface of the adjacent sawtooth roof, to underside or ceiling of sawtooth in question and thence being again diffusely reflected to room below (two reflections).

The total amount of light entering the building and due to the summation of the above four elemental quantities is therefore

$$L = d + rd + r_1c + r_2c \ldots\ldots\ldots\ldots\ldots (2)$$

The author has derived the following approximate formulae for determining each one of the quantities in Formula (2):

180 vers a

$$d\ (\text{per sq. ft. of } F) = \frac{[illegible]}{F} \qquad (3)$$

where S_{x-y} = [illegible] plane as de[illegible] Part 1;

b = [illegible] area S_{x-y}, a [illegible] properly [illegible] for S_{x-y}

[illegible]

$$[illegible]$$

as will become evident by inspection of Fig. 2;

$$rd \text{ (per sq. ft. of F)} = \frac{R_1 D \, [illegible] \, S_{x-y} \sin\left(b_1 + \frac{e}{2}\right)}{F} \ldots.(4)$$

where R = coefficient of reflection of ceiling

D = proportion of reflected light utilized to total, [illegible] may be taken as

$$\frac{180-g}{180} \text{ (see Fig. 3)}$$

g = [illegible] Fig. 3

$b_1 + \frac{e}{2}$ = average direction of light rays.

$$r_1c = KS_1R_2P_1\left(d + \frac{rd}{R_1D}\right) \ldots\ldots.(5)$$

where K = average ratio of quantity of direct sunlight and skylight incident upon one square foot of roof surface as compared with the quantity of skylight only incident upon and passing one square foot of lighting area S_{x-y}.

S_1 = ratio of effective roof area to lighting area S_{x-y}

R_2 = coefficient of reflection of roofing material

P_1 = amount of light obtained by reflection from roof, its proportional value included within any vertical angle g from any point P being represented by shaded portion of tangent circle in Fig. 4.

$$= \frac{g}{\pi} - \frac{\sin 2g}{2\pi}, \text{ approximately;}$$

or,

$d + \frac{rd}{R_1D}$ = quantity of direct sunlight incident upon and passing area S_{x-y} as determined by (3) and (4);

$$r_2c \text{ (per sq. ft. of F)} = KS_2R_1R_2P_2D\left(d + \frac{rd}{R_1D}\right) \ldots.(6)$$

where S_2 = ratio of effective roof area to light intensity computed for roof area included between sawtooth ridge and a horizontal line part way down roof representing average shade line on average day of year

P_2 = proportion of reflected light included between any vertical angle α, Fig. 5, from any point P

$$= \frac{\theta_2 + \theta_1}{2\pi} - \frac{\sin(\theta_2 + \theta_1)\sin(\theta_2 - \theta_1)}{2\pi(\theta_2 - \theta_1)}$$

and the other letters have the same meanings as in the preceding formulae.

It will be observed that no reference is made to any particular standard unit of flux or intensity of illumination and the formulae give only the relative or comparative amounts of light furnished under their several respective headings.

The following example illustrates the method of applying these formulae.

Numerical Example, Diffused Daylight Conditions. Given the same typical sawtooth roof as in the example in Part 1, having angle of glass = 73°. Required to find the total amount of daylight entering, that is, quantity L, Equation (2).

To find quantity d, equation (3): From the detailed building sections, it is found that b_1 = 72° 30′; b_2 = 86°; b_3 = 80°; x = 44″; y = 22″ whence

$$a = \frac{44\frac{72.5 + 86}{2} + 22\frac{86 + 80}{2}}{66} = 86° 30'$$

and

$$\frac{180 \text{ vers } a}{\pi a} = \frac{180(1 - 0.165)}{80.5\pi} = 0.592$$

Let the computations be based on a section of the sawtooth having a length equal to the width of one sash, i.e., 8′3″, the latter having a net width of glass equal to 7′3″. The length of span between valleys is 17′0″. From the foregoing,

S_{x-y} = 7.25 × 5.5 = 39.9 sq. ft. and F = 17 × 8.25 = 140 sq. ft.

Therefore entering Equation [3],

$$d = \frac{80.5 \times 39.9 \times 0.592}{140} = 13.6$$

TABLE I. VALUES OF (x) IN TERMS OF (b) AND (v)

b°	x for v = 70°	x for v = 75°	x for v = 78°	x for v = 80°
[illegible]	8° 11′	11° 03′	13° 50′	16° 30′
[illegible]	13° 28′	17° 59′	22° 18′	26° 16′
[illegible]	18° 29′	24° 28′	29° 52′	34° 36′
10	25° 30′	32° 57′	39° 24′	44° 32′
15	35° 28′	44° 01′	50° 40′	55° 41′
20	43° 15′	51° 55′	61° 05′	62° 43′
[illegible]	49° 15′	57° 36′	63° 20′	67° 22′
30	53° 59′	61° 49′	66° 59′	70° 31′
35	57° 36′	64° 58′	69° 11′	72° 56′
40	60° 30′	67° 22′	71° 42′	74° 40′
50	64° 36′	70° 13′	74° 30′	77° 03′
60	67° 15′	72° 48′	76° 12′	78° 30′
70	68° 49′	74° 05′	77° 18′	79° 22′
80	69° 44′	74° 47′	77° 50′	79° 52′
90	70° 0′	75° 0′	78° 0′	80° 0′

To find quantity rd, Equation [4]. From the detailed building sections, it is found as before that b_1 = 72° 30′; x = 44″; e = 25° 30′; g = 40°. Basing the computation on the same length of sawtooth as before,

S_x = 7.25 × 3.66 = 26.5 sq. ft.

F = 140 sq. ft.

also,

$$D = \frac{180 - 55}{180} = 0.7$$

Assume that ceiling of sawtooth roof is painted white and has a coefficient of reflection R_1 = 0.60. Then entering Equation [4],

$$rd = \frac{0.6 \times 0.7 \times 12.75 \times 26.5 \times \sin(72° 30' + 12° 45')}{140} = 1$$

which is relatively small compared with d.

To find quantity r_1c, Equation [5]. From the detailed building sections, it is found that q = 15°

$$= 0.26 \text{ radians, whence } P_1 = \frac{0.262}{\pi} - \frac{\sin 30°}{2\pi} = 0.004.$$

According to a publication entitled The Sun, by Charles G. Abbott, S.M., Director Smithsonian Astrophysical Observatory, the average intensity of sunlight plus skylight on this sawtooth roof may be deducted as being during working hours, and for ordinary atmospheric conditions, four times that of skylight on the lighting-area plane. Therefore, let K = 4.

S_1 from the detailed sections is found to be 2.3. Assume the roof to be covered with clean white slag having a coefficient of reflection = 0.5. Therefore, entering Equation [5],

$$r_1c = 4 \times 2.3 \times 0.5 \times 0.004 \left(13.6 + \frac{1}{0.6 \times 0.7}\right) = 0.3.$$

This quantity, represented by Equation 5, is usually so small that it may be omitted entirely from the computations.

To find quantity r_2c, Equation [6]. From the detailed building sections, it is found that

θ_2 = 80° = 1.4 radians

θ_1 = 24° = 0.42 radian

whence

$\theta_2 + \theta_1$ = 1.82 radians, and sin $(\theta_2 + \theta_1)$ = 0.97

$\theta_2 - \theta_1$ = 0.98 radian, and sin $(\theta_2 - \theta_1)$ = 0.829.

Therefore,

$$P_2 = \frac{1.82}{2\pi} - \frac{0.97 \times 0.829}{2\pi \times 0.98} = 0.16.$$

S_2 is found to equal in this case 2.7.

K = 4, R_1 = 0.6, R_2 = 0.5, and D = 0.7, as before. Therefore, entering Equation [6],

$$r_e = 4 \times 2.7 \times 0.6 \times 0.5 \times 0.16 \times 0.7 \left(13.6 + \frac{1}{0.6 \times 0.7}\right) = 5.8$$

Whence, Equation [2]

$$L = 13.6 + 1.0 + 0.3 + 5.8 = 20.7$$

This total quantity may be compared with a corresponding value computed for a sawtooth building already in service and of known degree of excellence as regards intensity of natural illumination.

In case additional illumination is required an alternate design having increased glass area or a flatter slope, or both, might be considered and in this connection it is interesting to note that if the pitch is decreased by only 10°, the glass area remaining the same, L figures out to be increased by about 15 per cent. On the other hand, assuming the building placed as in the first example and applying the principles of Part 2, it is found that considerable sunlight will enter for the entire day. That is, the period of total shade would be decreased on June 10 from more than 7 hr. to zero, direct sunlight being present continuously.

This information, when extended to comprehend that for other days of the year, including the day of average length, and when used in conjunction with the particular conditions and requirements of the problem in question (not excluding first cost), should facilitate the selection of the most advantageous design.

Various means have been adopted to exclude direct sunlight from the interior of such buildings, and all of them seem to have the disadvantage of reducing the total illumination. Sawtooth buildings with glass vertical, that is, with the effective angle of the lighting area actually overhanging are not uncommon; white-washing the glass results in some protection against direct solar rays and a cooler interior, but also in glare and considerable loss of light.

Whatever glass is used, cleanliness is essential; furthermore the significance of Equation [6], indicating the possible average relative amount of reflected light, emphasizes the importance of adopting where practicable, light-colored roofing materials such as white slag, and also the use of white dust-resisting washable paints upon sawtooth ceilings of buildings in which maximum daylight is desired. If either of the above surfaces had been black, the average reduction in daylight for the second example would have been equivalent to 30 per cent, or, expressing it another way, the increased light resulting from their use amounts to over 40 per cent.

As before noted, Part 2 of the paper should be applied only with due regard to its practical limitations. It furnishes a means of comparison with known designs and is based on fair-weather conditions and with sunlight on the building as a whole. During cloudy weather the amount of useful light contributed from the top of the sawtooth roof is, of course, decreased, but, on the other hand, the quantity of direct skylight, which has been found to constitute the major portion of the total, is often thereby considerably increased.

Conclusions—From the foregoing analyses it is evident that the height of valley (T, Fig. 5) for a given construction should be made as low as is consistent with protection against the elements, including snow and ice.

Furthermore, it will be seen that for a given building the use of a *small* number of *large-scale* sawteeth as against a greater number of *smaller* units having the same pitch, results in considerably increased daylight due to fewer number of valleys of height T, and consequently less proportionate obstruction. This principle, of course, should be applied with due regard to the structural limitations and the architectural considerations which may be involved, together with the important question of uniformity of daylight intensity.

It is also worthy of note that the adoption (for the reasons above outlined) of flatter sawteeth with increasing terrestrial latitudes works out well in conjunction with the heating requirements, since it results in less cubage and radiating surface.

Direct Design of Curvature of Arches

A short and accurate analytical method for finding the ordinates of the curve for concrete and masonry arches is described in The Canadian Engineer by Mr. Frank Barber, Consulting Engineer, Toronto, Ont. The matter following is taken from the above mentioned paper.

It has long been known that the transformed catenary is the curve of equilibrium for a linear arch under a vertical load area of uniform weight per unit area. This is shown in Fig. 1.

Fig. 1.

Let the linear arch S C S′ be in equilibrium under the load-area above it T T′ S′ C S.

Take O T axis of x.

O C axis of y.

Let A = area O C X Y

ω = weight per unit area of load-area.

H = constant horizontal thrust.

P = weight of load under O X.

Take a, so that $H = \omega a^2$ ....I.

Then $P = \omega A$.

$$\text{and } \frac{A}{a^2} = \frac{P}{H} = \frac{dy}{dx} \qquad \text{II.}$$

$$\text{and } A = \int_{x=0}^{x=ox} y\,dx \qquad \text{III.}$$

$$\frac{d^2 A}{dx^2} = \frac{dy}{dx} = \frac{A}{a^2}$$

Integrating

$$A = V e^{\frac{x}{a}} + W e^{-\frac{x}{a}}$$

Where V and W are constants to be determined:

When x = o, A = o, and $e^{\frac{x}{a}} = e^{-\frac{x}{a}} = 1$.

and the above equation can be put in the form

$$A = V\left(e^{\frac{x}{a}} - e^{-\frac{x}{a}}\right)$$

$$\frac{dA}{dx} = \frac{V}{a}\left(e^{\frac{x}{a}} + e^{-\frac{x}{a}}\right) = y \text{ from III}$$

When x = o, y = y_0

$$y_0 = \frac{2V}{a}$$

and the above equation becomes:

$$\frac{y}{y_0} = \frac{e^{\frac{x}{a}} + e^{-\frac{x}{a}}}{2} \qquad \text{IV.}$$

which is the equation to the curve.

This curve was made the basis of a direct method of design for masonry arches, where no tension in any part of the arch ring was desired, by Alexander and Thomson* whereby the line of resultant pressure for dead and live loads may be kept within the middle third of the ring. Otherwise small mention has been made of it in late works on arches.

In important arches it has often been considered worth while to fit the line of resultant pressure for the dead load by graphical methods to coincide with the middle line of the arch ring, so that under the dead load there shall be no bending moment at any section of the arch ring. This curve is chosen in order to be economical of material, for the principal stresses from other than the dead load are reversible moment stresses of about equal amounts, positive and negative. It is not, however, the arch of exactly minimum material where the dead loads alone are taken for the equilibrium curve, as there are exceptions to the above statement as to reversible stresses of equal amounts which may be taken account of. But any part of the distributed live load may be taken along with the dead load in forming the equilibrium curve just as easily as the dead load alone. It is therefore unnecessary for the purpose of this article to discuss further the arch of minimum material.

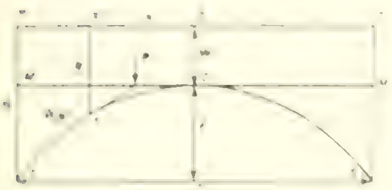

Fig 1

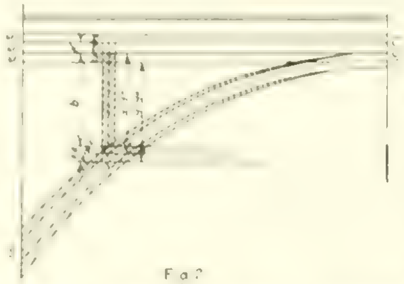

Fig 2

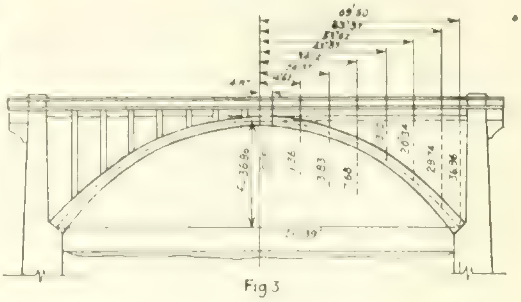

Fig 3

Fig 1—Curve of Equilibrium for Homogeneous Loading.
Fig 2—Identification of Conditions in an Open Spandrel Arch with Those Asumed in Fig. 1.
Fig 3—Typical Open-Spandrel Arch as Example.

The curve of the middle line of the arch may be found so that it coincides with the equilibrium curve by the following analytical method. This applies to open spandrel arches where the weight of the floor system (as distinct from the spandrel vertical supports and the arch ring) is uniform per lineal foot and to earth-filled arches if the pressure of the filling is assumed to be vertical.

In these cases part of the dead weight is uniform per horizontal foot, the weight of the floor system and part of the arch ring, and that part of the spandrel supports (as these are ordinarily designed), if any, which lies above the level of the crown—in fact to all of the arch system at the crown. The rest of the arch dead load varies from zero at the crown, C, to a definite amount at the skewbacks, S, S'. Let us call these parts I. and II. Let the area M M' T T' represent I, and the area S C S' M M' represent II. The weight of the spandrel supports (or that part of them in II) will vary sensibly as the ordinates between M M and the curve. We must assume that the spandrel supports are of uniform section and spaced equally, and that the floor system is of uniform weight per horizontal foot, in accordance with usual practice. Let us further assume for the present that that part of the ring which varies from zero at C to any amount we wish at S varies according to the same law. Here f represents the actual rise of the linear arch, but y_0 is, of course, not the actual height of the floor system. Its meaning is not of practical interest. It is the height to which the part of the arch in I would rise if it weighed the same per cubic foot as the part in II, the latter supposed to be distributed uniformly over M M' S C S'.

We may suppose the dead weight to be thus distributed, in which case let it weigh ω lbs. per cubic foot.

Assume that the linear arch S C S' is the equilibrium curve and also the middle line of the arch ring. Then we find as follows—

The last term of IV is an hyperbolic function, cosh $\frac{x}{a}$. Tables of these functions were prepared by the Smithsonian Institute and published in 1909.† We shall have recourse to them in what follows.

The equation of the curve then becomes—

$$\frac{y}{y_0} = \cosh\frac{x}{a} \quad \ldots\ldots\ldots\ldots \text{V.}$$

We have

ωy_s = weight per lin. ft. of whole arch system at S = S (say) which must be computed, ...VI.

ωy_0 = weight per lin ft of arch system at C = C (say) which must be computed ....VII.

When $x = \frac{1}{2}l$, $y = y_s$

$$\therefore \frac{y_s}{y_0} = \cosh\frac{l}{2a} = \frac{S}{C} \text{ (from VI and VII.)}$$

whence a is found from the tables.

Also—

$$\frac{S}{C} = \frac{y_s}{y_0} = \frac{f}{y_0} + 1 \quad \ldots\ldots\ldots\ldots \text{VIII.}$$

whence y_0 from VIII, ω from VII and H from I.

We are now ready to tabulate the values of x for as many points on the curve as is required, say the points at the feet of the spandrel posts, or 8 or 10 points for the half arch. Then tabulate $\frac{x}{a}$, cosh $\frac{x}{a}$ and $y_0 \cosh\frac{x}{a}$ which gives the value of y. It will now be convenient to subtract y_0 from each value of y giving the ordinates $y - y_0$. We then have the abscissae and ordinates of the curve conveniently on a horizontal line through the crown of the linear arch and perpendicular to it.

Let us now examine the assumptions made above as to distribution of weight. In Fig. 2 the central part of the ring is that part which is of uniform weight per horizontal foot, part 1. The shaded portions are part 2 of the ring, varying from zero at C to anything required at S. Also any one spandrel post is shown, the shaded part being part 2 of it. The shaded parts of the rib have been assumed to vary in weight per horizontal foot from C to S according to the ordinates $y - y_0$. Suppose the rib to have been designated as to intermediate depths between C and S in this way, then we prove as follows:—

A B = C C', = D E ....(a)

Since the weight of this part of the rib is uniform per horizontal foot

$\therefore$ B E = A D = $y - y_0$ ....(b)

Also B C varies as $y - y_0$ ....(c)

Let B C = a,
C E = b.

Let similar parts of any other post be a', b'.

$$\text{Then } \frac{a+b}{a'+b'} = \frac{y-y_0}{y'-y_0} \text{ from (b)}$$
$$= k, \text{ say}$$

$$\text{Also } \frac{a}{a'} = k \text{ from (c)}$$

$$\therefore \frac{a'k+b}{a'+b'} = k$$

$$\text{whence } \frac{b}{b'} = k$$

or C E varies as $y - y_0$.

Now C E is all that part of the post in division II, as the part (if any) above it is the part above the extrados of the ring and is of uniform weight per horizontal foot if the spandrel posts are equally spaced and of uniform section.

We have now shown that all that part of the bridge which is not of uniform weight per horizontal foot varies

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*On [illegible] Curves and their Application to the [illegible] Segmental Arches. Transactions of the Royal Irish Academy, Vol. XXIX., part III., [illegible]

†Smithsonian Mathematical Tables. Hyperbolic Functions. Published by the Smithsonian Institution, Washington.

from zero at the crown to any required weight at the skewback, directly as the ordinates $y - y_c$, as required by the theory, but we must design the intermediate depths of the arch ring accordingly, although we may choose any depth at the crown and any other at the skewback. When the depths of the latter sections are so chosen as to make the same maximum stresses at both crown and skewback then the ring with intermediate depths chosen as above is almost ideally correct for arches with fixed ends, judging by various arches analyzed by the writer, but is slightly in excess of the requirements along the middle haunch where temperature moment stresses are small. But if the arch of ideal depth at all points is sought and found by repeated trials it will not differ at all from the one here assumed at the crown or skewback, and only so slightly along the haunches as to make no appreciable difference in the line of resultant pressure for the dead load of the arch system.

It is desired to apply this method of design to an arch which does not fulfil the conditions required, as for instance, where by reason of the ring touching the floor slab at the crown (as in some flat arches) the floor system is not of uniform weight throughout, the limits of probable error may be indicated in this way.

Compute the weight of the arch and then compare it with the weight of the assumed arch W (say) which is—

$$W = \omega \int_{-\frac{1}{2}}^{\frac{1}{2}} y\, dx$$

$$\text{or } W = 2 a \omega y_c \operatorname{Sinh} \frac{1}{2a}$$

But in arches which fulfil the conditions the above expression gives the readiest method of getting the total weight, and without computation except for the weight per lineal foot at two points, the crown and the skewback.

Some of the advantages of this method of designing the arch curve may be mentioned.

It gives a very direct method of finding the dead load horizontal thrust. After the floor system is designed and a depth assumed for the arch ring or ribs at the crown and at the skewback a few minutes computation (before the ordinates to the curve are computed) will give the correct stresses at the crown and skewback due to the dead loads. It is an advantage to know this before proceeding further with these computations and the analysis of the ring by the theory of elasticity, as it may lead to a revision of the arch depths without waste of labor, especially in great arches where the dead load stresses are the main stresses.

It allows a check on not only the final work here shown for finding the curvature, but on almost the final work in analyzing the arch by the theory of elasticity. If when the final coefficients in the latter analysis are found the dead load moments are sought at any point, as for instance the crown, and found to be zero, then the correctness of the curvature as well as of the coefficients themselves are verified.

An Example Worked Out.

1 = 139 ft.

f = 36.96 ft.

S = weight per lin. ft. of bridge at skewback for a longitudinal strip one foot wide = 890.6 lb.

C = weight per lin. ft. of bridge at crown for a strip one ft. wide = 361.7 lb.

$$\operatorname{Cosh} \frac{1}{2a} = \frac{\omega y_s}{\omega y_c} = \frac{S}{C} = \frac{f}{y_c} + 1 = \frac{890.6}{361.7} = 2.4623.$$

$$\text{From tables } \frac{1}{2a} = 1.5502$$

Whence a = 44.834

$$\text{also } \frac{f}{y_c} = 2.4623 - 1.$$

Whence $y_c = 25.276$,

and $\omega y_c = C = 361.7$

Whence $\omega = 143.10$,

and $H = \omega a^2 = 28{,}764$ lb.

Now proceed to find as many points on the curve as necessary. Here we divide the span 139 ft. into 15 equal divisions of 9.75 ft., a spandrel post being at each division point, the crown being midway in the central division. The first value of x will be one-half of this division, 4.875 ft., the second 9.75 ft. more, and so on, as in Column I. The other columns are then easily computed.

I	II	III	IV	V
[illegible]	x/a	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	Ft.
[illegible]	[illegible]	[illegible]	25.462	.150
[illegible]	[illegible]	[illegible]	26.633	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	3.827
[illegible]	[illegible]	[illegible]	32.958	7.682
[illegible]	[illegible]	[illegible]	[illegible]	13.101
[illegible]	[illegible]	[illegible]	45.618	20.342
[illegible]	[illegible]	[illegible]	55.021	29.745
69.500	1.55020	1.79405	62.237	36.961
[illegible]	[illegible]		315.375	113.167
			[illegible]	
			113.167 check.	

log Σ x = 2.4890791

log a = 1.6516033

$$\log \Sigma \frac{x}{a} = [illegible]$$

$$\Sigma \frac{x}{a} = 6.87810 \text{ check}$$

The abiscissae and ordinates to the curve are given in columns I and V along a horizontal line through the crown and perpendicular to it.

Safety Treads For Stairways

Interesting information on safety treads for stairways was brought out by Mr. Carl King in a discussion of a paper on Factory Stairs and Stairways presented at the annual convention of the American Society of Mechanical Engineers. An abstract of Mr. King's discussion follows:

A safety tread, in order to be permanently effective, should be so designed as to meet abnormal or unusual conditions of almost every character. On stairways which are exposed to the elements the treads are flooded in rainy weather, and if the temperature is very low the water becomes a sheet of ice. Under traffic water and dirt form a slimy coating over the treads, which renders them very dangerous to walk upon.

Many accidents are caused by conditions which are common to stairways inside as well as outside of buildings. The presence of foreign substances on the tread surface, such as fruit peelings, cigar and cigarette ends, scraps of paper, pencils, or burnt matches, when on a flat surface act as anti-friction agents and are the direct cause of many accidents.

In order that there may be absolute protection from slipping, a safety tread should be so designed as to provide for direct contact between the shoe sole and the tread surface under any and all conditions. Preferably, the tread surface should be so designed with grooves, or corrugations of ample size to provide channels for the drainage of water and the displacement of any substance; the higher parts thus being left clean and dry. To be effective, the channels should be of such width and depth as will insure a direct contact surface, and the contact surface itself should consist of anti-slip material, such as lead or an abrasive composition, which will remain uniform until the tread is completely worn out.

In the matter of cleanliness, it can readily be seen that any foreign matter dropped upon the tread or scraped from the soles of shoes can be swept to the end of the tread, which need not extend to the skirting or baseboard, and thence down the stairs, making it as easy a matter to keep the stairs clean as though there were no safety treads upon them.

Cost of Erecting Entrance Pillars

BY H. R. FERRISS

The following costs were incurred at the erection of entrance pillars for a private estate. All materials were delivered at the work by the owner. The labor was performed under contract and the rates are therefore assumed but the hours are correct.

The pillars and the foundations for the grills were built of a tough, smooth grained, cream colored sandstone. The stones were delivered on the work in blocks, previously rough cut at the quarry, of the approximate size and shape required in the completed work, and were then finished by hand to the owner's somewhat exacting requirements. The face of all stones were dressed with 4-line cuts.

Entrance Pillars on East Side of Roadway. Pillars on West Side Were Identical

The foundations for the sandstone consists of 1:3:5 concrete of the dimensions shown on the sketch. In the center of each pillar there is a 2 in. galvanized iron pipe to serve as a conduit for the electrical connections to the lamps. The "stones" are anchored in mortar but are so skillfully fitted, that the face of the "stones" presents an absolutely solid appearance at a distance of a few feet.

The work was well handled and the costs, considering the requirements of the job, are believed to be low.

The contract price (four years ago) for furnishing all labor connected with the work, excepting the delivery of materials only, was $1,200. The rates are believed to be less than the contractor actually paid. The weather was good during the entire month taken to complete the work.

The cost of the materials was as follows:

Bronze name plates (2)	$ 300.00
Bronze electroliers (2), large	
Bronze electrollers (2), small	
Models for above	65.00
Lamp globes (4)	20.00
Grills as per sketch (2)	250.00
Electrical materials	25.00
Paint for grills	3.00
Stone (delivered)	300.00
Machine work on grills, name plates, etc.	12.00
Miscellaneous material	15.00
Cement, sand and gravel (8 cu. yd.)	37.00
	$1,027.00

Cost of delivery, excepting sandstone, is not included

It is interesting to note that the manufacturer of the grills, name-plates, and electroliers states that they could not be produced today for much less than twice their cost four years ago.

The net labor costs were:

Excavation for foundation	
Labor, 40 hr. at 30 ct.	$ 12.00
Team (haul away surplus earth), 6 hr. at 75 ct.	4.50
Total	$ 16.50
Placing concrete:	
Foreman, 4 hr. at 65 ct.	2.60
Labor, 20 hr. at 30 ct.	6.00
Total	$ 8.60
*Erecting derrick:	
Labor, 12 hr. at 30 ct.	$ 3.60
Team, 1 day at $7.00	7.00
Total	$ 10.60
Erecting stone cutters' shed:	
Labor, 16 hr. at 30 ct.	$ 4.80
Cutting, shaping and finishing stones.	
Stone cutters, 402 hr. at 65 ct.	$261.30
Helpers, 700 hr. at 45 ct.	315.00
Total	$576.30
†Erecting and fitting stones, name plates, lamps, etc., in place.	
Foreman, 99 hr. at 65 ct.	$ 64.35
Labor, 164 hr. at 35 ct.	57.40
Team, 4 hr. at 75 ct.	3.00
Total	$124.75
Pointing and cleaning stone work	
Labor, 32 hr. at 50 ct.	$ 16.00
Painting grills:	
Labor, 16 hr. at 35 ct.	5.60
Cleanup, remove stone scraps, etc.	
Motor truck, 6 hr. at $4.00	$ 24.00
Labor, 20 hr. at 30 ct.	6.00
Total	$ 30.00
Electric connections, etc.:	
Electricians, 16 hr. at 75 ct.	$ 12.00
Helpers, 12 hr. at 50 ct.	6.00
Total	$ 18.00
Blacksmithing (estimated)	15.00
Total cost of labor	$826.15

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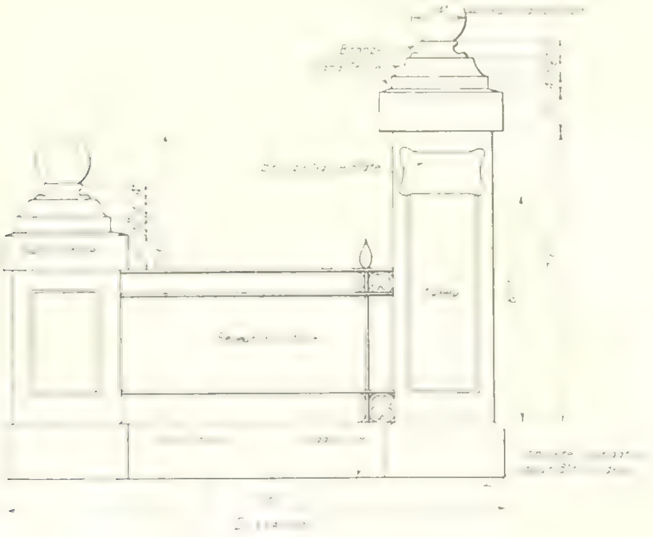
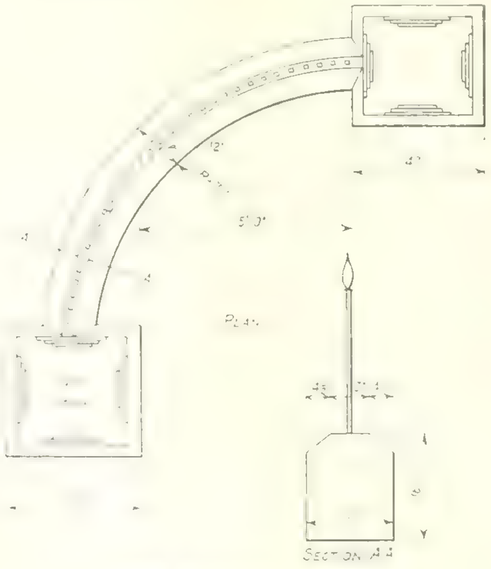
*Derrick was first erected on one side of roadway and then moved across the road for the other side of the gate. †This labor could not be separated.



Elevation of Entrance Pillars.



Plan of Entrance Pillars.

Engineering Societies' Committees on Aims and Organization*

By ARTHUR N. TALBOT

The work given to the committees which have been formed by at least three of the Founder Societies has its purpose well expressed by the name given to the committee of The American Society of Mechanical Engineers the Committee on Aims and Organization. The resolutions of the Board of Directon of the American Society of Civil Engineers creating the Committee on Development of that society instructs the Committee to report on the purpose, field of work, scope of activity and usefulness, organization, and methods of work of the society. It is apparent that the committees have much in common and that there should be full and free co-operation. What should be the aims and purposes of such societies, how they may best be organized for present-day conditions, and what they may be expected to accomplish are then within the scope of the work of these committees.

These are times of development. The great world war and all the attending phenomena have brought about new conditions. Men are thinking outside the lines which formerly limited their thoughts and methods. The existing state of flux in socioligical and economic conditions may deeply affect the opportunities and responsibilities of the engineer. Great changes and great development may be expected to follow. It is apparent to many observers that a larger sphere of activity and usefulness will be opening to the profession of engineering, if only the engineer is ready to undertake his part now and later. And, besides, the engineers' work has developed so rapidly and so diversely in the past 40 years that we hardly know where we are. Engineering societies have grown at a very rapid rate; local and specialized engineering societies have sprung up everywhere. The conditions in the more remote parts of the country may differ materially from those in and around New York. In all there are some 35,000 members of the four national engineering societies. How many there are in the hundreds of local and specialized engineering societies is not known. It is considered by some that the number of men who may justly claim the right to be classed as engineers runs up to more than 100,000.

In view of all this is it not well to seek to make a survey of the aims and purposes of the engineering societies, to ask whether they are occupying all the fields of usefulness open to such societies and whether they are accomplishing all that may reasonably by expected of such organizations?

Even if the survey made by the committees should result only in broadening and intensifying and emphasizing the activities, functions and methods of work already in existence, the effort will be worth while. More likely, the study of the problems will show new opportunities and responsbilities devolving upon the societies, and especially that, whether inside or outside the field of the national engineering socities, there are matters of public and semi-public nature which should be considered by the engineering profession more fully than has been the case in the past.

In taking up this inquiry no one should feel that the consideration of aims and organization is in any way a reflection on the conduct of our societies in the past. All will agree that their record is most excellent. The accomplishments of the societies, technical and extra-technical, redound to the credit of the societies and their membership. These societies have helped to create the engineering profession. In ways that are not usually recognized the engineering society has been a benefit to the engineering profession and to the public. It has given esprit de corps to the profession. It has made its members feel self-respecting—more, it has shown many the high standing of the profession and the responsibility attached to membership in it. It has raised the standards and the standing of the engineering profession, and has assisted in establishing this standing in the eyes of the public. In such ways as this it has more than justified its existence. But may not the engineering society do even more than it has in giving standing to the engineering profession?

The engineering society has been very helpful in technical matters. In fact, in the eyes of many, the presentation and discussion of papers on technical engineering subjects should be almost the sole function of the engineering society. This is a worthy function. Engineering is and must continue to be a technical art, a technical business. Is it not likely, with the great development of the science and art of engineering, that the engineering society has not yet realized the possibilities of its usefulness in developing, recording and disseminating the technical side of engineering, the scientific substructure, the overlying elements of practice, the variform connections with business life? Especially may it not be more fruitful in contributing to engineering knowledge and in creating or developing new engineering policies, and in developing engineering practice and engineering improvements?

If one were to recount the accomplishments of the engineer in civic affairs, in governmental activity, in influence upon public policy, in the solution of industrial problems, the record would be surprising and greatly to the credit of the engineer. The accomplishments of the engineering societies along these lines are likewise very creditable. But as new conditions teach new duties, it is worth while inquiring whether the engineer and the engineering society have not now opportunities and responsibilities in the direction of public duty far beyond that which has usually been considered a sufficiency. If a need is found, means must be found for expansion, if such expansion is practicable. The problem is a complicated one. The engagements of most engineers are not like those of the lawyer. There is a great diversity of condition of service and environment, even in the same lines of engineering. It is also evident that matters affecting general public policy, to have the best effect and the greatest influence, should be discussed by all branches of engineering in every part of the country; and matters of regional, state or local interest may be handled only by those in the localities interested.

It is becoming more and more apparent that engineering is a single profession; the various branches merge and ramify into each other in numerous ways. Many engineers think that there should be one large inclusive engineering society to take the place of the several national societies—but evidently that is not a present probability. Much has been done in recent years in the way of co-operation and united effort; the United Engineering Society and the Engineering Council have unified action in commendable ways; there is a great field for their further endeavor. In any discussion of the subject it must be borne in mind that the membership of the national societies is scattered over the country; that there are numerous centers of engineering and that these are yearly becoming more important; that local engineering societies in these centers are essential elements in the life of the engineering profession; that these local societies furnish the means by which the young and growing man meets and knows other engineers and gains opportunity for development; and that the national societies may be greatly strengthened and their influence extended by closer affiliations with these local societies; and that any thorough consideration of the subject of aims and organization should endeavor to find ways and means by which the sections of the national societies may best effect close co-operation with the local societies and extend the opportunities of members and the influence of the engineering profession. The problems of the co-ordination and unification of the engineering profession are numerous and complicated, but nevertheless no one will doubt that every effort should be made to strengthen organization and to attempt to make the engineer a leader [illegible] the world.

It is apparent that the subject assigned to the committees will require diligent and earnest study and consideration, and that their reports will need careful deliberation by the societies. What are the best lines for expansion and improvement and what can be accomplished for the good of the profession and the public are matters which may well tax the powers of the [illegible] and the membership, what is practicable and what is visionary, what may be done by the engineering society and what may best be relegated to [illegible] or [illegible] or separate organizations or given up entirely, must all be threshed out [illegible]

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*Abstract of address delivered [illegible] The American Society of Mechanical Engineers.

President American Society [illegible] Municipal and Sanitary [illegible] Am. Soc. M. E.

The Structural Engineer and Contractor As Rivals of the Architect

In an article in the Architectural Record, Mr. Wilfred E. [illegible] brings out some interesting points on the present and future status of the architect in his relations with the general contractor. [illegible] from the article follow.

Architects of present day practice have become so accustomed to the general contractor and his apparent necessity that they are likely to overlook the fact of his so-recent evolution. Witness that portion of the American Institute definition of an architect, which describes one of his functions as "supervising the operations of contractors," instead of "supervising construction." And some architects, much to their discomfiture, have been made to realize that, in bringing forth this individual for the purpose of shouldering some of the onerous duties incidental to actual construction, they have hatched out a veritable cuckoo bird, which bids fair to oust its foster parents from their perch.

Architects may ascribe to themselves all the dignity they can throw into their profession, and then add a modicum, without being able to overcome the opprobrium that attaches to the office of the "gum-shoe" artist, which office, in the mind of the average owner, the architect deliberately assumes when undertaking to superintend a work of construction.

The triangular relation is the direct outcome of the building up of the contracting system, which, in turn, was the result of commercial conditions of a by-gone generation. Time was, not so very long ago, when commercial probity was a joke; when a buyer had no protection but his own acumen, and when great wealth was its own justification, regardless of the means of accumulation. Under such conditions, neither reinforced concrete nor heaviest armor plate were barriers too strong behind which to safeguard the interests of the most wary individual when he found it necessary to enter into a building agreement with a rapacious contractor. Small wonder either that, under such conditions, the detective hireling sometimes went wrong. With the owner trying to beat the contractor full as often as the reverse, the architect must have been a superior personage indeed if, after having been forced down to the lowest possible fee for himself, he did not try to recoup when opportunity offered. Evidence might be adduced to show that he did—too often for his own reputation and that of the confreres.

The writer has in his mail today a printed circular from the manufacturer of a building appliance, containing the following paragraph:

"The prices shown on page 23 are list—the prices your customer should pay. You are entitled to a trade discount of 10 per cent."

And the circular was prepared for distribution among architects, though worded as if for supply houses.

The general contract system is the simplest one for an architect to handle. With it goes the added employment of the architect as superintendent and the additional fee as well. Without it, the owner is too often convinced that the entire service of the architect can be dispensed with. And there's just the rub; it can.

Mr. Sturgis, defining "Contract," takes occasion to step aside from the limited path of the lexicographer and to remark editorially that "it is probable that there will be no great improvement in the artistic results of architects' practice until the commission system is done away with. This improvement can hardly be made, however, under the contract system. The two seem to belong together; the architect being recognized in the contract as an essential third party to that contract, is naturally paid by a percentage on the amount of money represented in the contract."

Now, if the architect chooses to be a lofty professional character, an artistic designer only, rather than a complete "creator of structures," why then should he not be employed either by the builder or the owner, it matters not which, to be just the designer, the actual working out of the design being left to the contractor or building entity, their excellent draftsman, and their field forces for carrying the work through to completion?

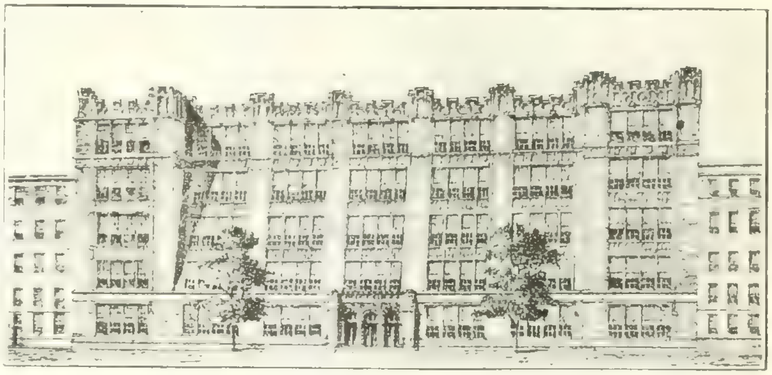
This is one solution, and many ethical practitioners, as well as other able draftsmen, have been so employed sometimes, furnishing designs only, sometimes more complete working drawings, the engineering and other details being left to the contractor's own forces. In fact, there probably are today more capable structural engineers in the employ of contractors than of architects—a condition largely due to a manifest disposition on the part of many of the best architects to leave their engineering problems to outsiders, specialists in those lines. Perhaps it is this very assumption of high ethical professionalism on the part of the architect which has greatly assisted in giving the general contractor his ascendancy in this age of intensified commercialism.

Now, some of these, wiser, perhaps, than their brethren, and not quite such sticklers as to ethics, have discovered in the evolution of the drafting rooms of contractors and supply houses a perfectly simple solution of the problem of "making ends meet." They argue—and who shall say unjustly—that inasmuch as one of the chief features of the owner's building problem is economy, as is manifest by his refusal to pay a proper fee for architectural service, then why burden him (or the architect) with dual expense for detail drawings? Thus the upbuilding of the contractor's drafting room, as aforesaid.

It may not be surprising in the near future, if indeed such is not already the case, to find contractors equipped with drafting forces equal, if not superior, to those of some of the architects under whose direction they have been accustomed to work.

Inclined Walls and Windows of School Buildings Increase Supply of Natural Light

Much of the school building work of New York City occurs in localities which are being rebuilt, single family or small houses giving way to the multiple family houses of four or perhaps five stories in height. This results in a very large increase of land value, which operates against the acquisition of a large site for the school. The streets oftentimes are very narrow, so that the problem of obtaining sufficient light in the class rooms on the second and third stories has been very great. A study of these local



Design Showing Scheme for Obtaining Additional Light in Narrow Streets.

conditions, stated Mr. C. B. J. Snyder, Superintendent of School Buildings of New York City, in a paper presented Sept. 25 before the Society of Municipal Engineers of New York, has led to a design in which the upper stories of the facade of the building are inclined to an angle of about 15 degrees from the vertical, so as to permit of the light from the sky being admitted to each room. This design presents certain economic features as to natural lighting of the interior, which are essential, and seemingly, under the local conditions, can be obtained in no other way.

U. S. Shipyards Complete Vessels of 3,103,583 D. W. T. in 1918

During 1918 ships of a total dead weight tonnage of 3,103,583 were delivered by shipyards holding contracts with the Emergency Fleet Corporation and those building vessels requisitioned by the corporation. This total includes 1,620,452 tons of requisitioned steel ships, 949,625 tons of contract steel ships, 376,400 tons of wood vessels, 37,500 tons of composite ships and 119,606 tons of steel ships built in Japanese yards.

The deliveries from the time that the Emergency Fleet program was started until the end of the year 1917 aggregated 301,889 deadweight tons. This comparatively small figure for deliveries during the five months from August to Dec. 31, 1917, may be regarded as evidence that the tonnage requisitioned on the ways was not a great factor in bettering the showing made by shipworkers in the early part of the program. Different types and designs of the requisitioned hulls prevented any successful effort at standardization in the early days.

There was a decided slow-down in deliveries during the last two months of 1918. This was due to the fact that the armistice had removed the emergency, to meet which the nation entered upon its shipbuilding program; that all overtime, Sunday and holiday work was eliminated; certain changes were made in ship construction to fit the vessels for peace-time needs, and regulations governing the testing of vessels were changed materially to require a more rigorous trying-out of each ship before acceptance.

The total tonnage may be increased by reports not yet received of ships actually delivered in December, but those additional ships will be listed as January deliveries.

The deliveries from the time that the Emergency Fleet program was started up until the end of the year 1918 aggregate 580 ships of 3,405,392 tons. This represents the total tonnage of new shipping accepted since August, 1917, when the first ship of 2,930 tons was delivered. It does not, however, represent all the work done in the shipyards, for there still are millions of erected tonnage either afloat and awaiting final completion and acceptance, or in various stages of construction on the ways. The latest figures on the construction work during the year show that a large per cent of the work program, as measured by ship tonnage created, was completed.

This work program includes the tonnage delivered and in operation, the tonnage launched but not delivered and the tonnage partially constructed but not launched.

The ships delivered and in operation can, of course, be considered as 100 per cent completed work. A reasonable estimate fixes the stage of completion of a ship launched but not yet delivered at 80 per cent, and it is reasonable to estimate the average stage of construction of vessels still on the ways at 33⅓ per cent of completion. The following table gives a summary of performance in the shipyards in 1918 in terms of ship tonnage created:

	Total ship tonnage work program 1918 D. W. T.	Stage of completion Per cent	Tonnage created D. W. T.
Delivered and in operation	[illegible]	100	[illegible]
Launched but not delivered	[illegible]	80	[illegible]
Partially constructed but not launched	[illegible]	[illegible]	[illegible]
Totals	[illegible]		[illegible]

The performance indicated by these figures shows that America, for the first time in more than half a century, led the world in ship production.

Heating Systems of New Plant at Essington Works

Unusually modern heating and ventilating systems have been installed in the new marine equipment plant of the Essington Works of Westinghouse Co. at South Philadelphia.

The various heating systems throughout the works come under the general head of "vacuum heating." Steam is supplied through large exhaust mains in tunnels to the different buildings and the water of condensation is drawn through the return mains by vacuum pumps located in the power house. Vacuum or thermostatic traps are used on each unit of radiation throughout the installation, which in conjunction with the vacuum pumps, make it possible to obtain a positive circulation of steam throughout the entire plant at a low initial steam pressure.

Ventilation is not considered in a plant of this size as much of a problem, because this feature is already taken care of in the design of the buildings, where large areas of ventilating sash are provided, and where the ratio of cubic contents to the number of occupants in each building is unusually large. Small exhaust systems of ventilation were installed in the west end of machine shops Nos. 1 and 2 to provide for unexposed offices, wash and toilet rooms. In the various shop buildings the indirect blower systems were installed, their selection being due primarily to their adaptability to this class of structure, their lower first cost and better distribution of heat, as well as convenience of operation.

Direct heating was installed in the office section of the pattern storage building as well as in the building proper. The direct heat in this case provides the necessary individual control in the offices, and the most economical system for the rest of the building. Direct heat is provided in the toilets and wash-rooms throughout the plant to prevent freezing when the indirect blower systems in the shops are shut down.

The indirect blower systems in the machine and erecting shops, and in the foundry, were divided into two units, on account of the size of the buildings. Each unit consists of a constant-speed motor-driven blower and indirect heater. The heater is so subdivided that the air temperature may be adjusted to suit any outside temperature. The heated air is carried through a system of overhead sheet-iron ducts, with outlets carried down the columns to distribute the heat near the floor. Provision is made in each blower room, so that air may be taken directly from outside, or the warm air recirculated from inside the building. It is the intention that all air be recirculated during the night, and when the shops are not in operation, as this will effect a considerable saving in steam. At other times, during mild weather, the system may be operated partly on outside air and partly on recirculated air. In extremely cold weather, it will be necessary to operate entirely on recirculated air, in order to properly heat the buildings.

This does not apply to the foundry, where it will be necessary to operate on outside during working hours, owing to the nature of the work performed in the building.

The following data, tabulated for each building, give detailed figures regarding the size and capacity of apparatus, as well as information showing temperature ranges and length of time required to completely change the air in each building.

[illegible]

[illegible]

Foundry:

[illegible]

[illegible]

School House Contracts Amounting to $100,000,000 Held Up by War

[illegible] public school houses, totaling some [illegible] held up as a result of the war, according [illegible] tabulation of building conditions throughout the United States, which has been made by the Statistical Section of the Division of Public Works [illegible] U. S. Department of Labor. [illegible] the completed tabulation will show that these school projects, now being held in abeyance, aggregate more than $100,000,000.

In round numbers, this is about $1 per capita throughout the United States. As school buildings are customarily financed on 20-year serial bonds, this means an installment [illegible] per capita per year by the people of this country, if they would have their school program put [illegible] present time.

Assuming that a decrease of 20 per cent in construction costs might develop during the next 4 to 5 years (and this is regarded by many as a maximum decrease), the immediate completion of the nation's school program would involve an excess of only 1 ct. per capita per year over the per capita cost, even if constructions were delayed for several years.

War Restrictions on Building.—In an address at the Atlantic City convention of the National Federation of Construction Industries, Mr. D. R. McLennan, Chief of the Non-War Section of the War Industries Board, gave some interesting figures on the effect of the war regulations regarding building construction. He stated that from Sept. 4, the day the restrictive ruling was put into effect, up to and including Nov. 10, the day before the armistice was signed, there were issued 1,056 licenses for new construction of which 699 were on farm buildings. Eliminate the 699, and 96 issued for housing projects as recommended by the United States Housing Corporation, and there were just 261 licenses issued in the entire United States for new construction projects. The total amount of 1,056 represented in dollars $6,530,000—$1,619,000 of which was on farm buildings. That left $4,911,000 of new construction in the commercial centers of the country, exclusive of farm buildings and these housing projects. This means less than $2,000,000 per month, as against about $200,000,000 per month in normal times, assuming that the total building of the country is $2,400,000,000.

First Large Concrete Boat Crosses Lake Erie.—Barge "U. S. 101," built by Thomas E. Currie of Detroit for the New York Canal Section of the Division of Inland Waterways, arrived at Buffalo, Dec. 2, after having weathered a gale on Lake Erie. This is the first concrete craft to have crossed Lake Erie. It is the first of a fleet of 21 similar concrete canal barges to be completed for service on the New York Barge Canal. These barges are larger than any that have yet been put into service on the canal. They have an over-all length of 150 ft. and a beam of 21 ft., with a carrying capacity of 500 tons on 10 ft. draft. Four barges have been launched, one at Fort Edward, one at Ithaca, and another at Detroit. When completed, the first two of these will see service on intercoastal routes in the South until spring. Winter weather has prevented the launching of two other barges, one at Tonawanda and a second at Fort Edward.

Personals

E. P. Low has resigned as city manager of Brownwood, Tex.

Ole K. Olsen, consulting engineer, New Orleans, La., has been elected president of the Louisiana Engineering Society.

Ward E. Pratt of Rochester, N. Y., has been appointed research engineer of the engineering experiment station of the University of Illinois.

E. H. Bruyere, George Sexton and H. V. Campbell have organized the E. H. Bruyere Construction Co. of Waco, Tex., and will engage in general contracting.

Charles W. Carkeep has been elected president of the Master Builders' Association of Seattle, Wash. The other officers are: Vice-president, F. A. Harrington; secretary, J. E. Shoemaker; treasurer, E. J. Rounds.

Esli Knight, treasurer of the Tampa Dock Co., Tampa, Fla., has become general manager, succeeding Jack McGucken, resigned. The company is engaged in constructing wooden ships for the U. S. Shipping Board.

A. Yappen has been appointed assistant engineer in charge of bridge maintenance, inspection and erection on lines east of Mobridge for the Chicago, Milwaukee & St. Paul R. R. He succeeds C. N. Bainbridge, promoted.

J. L. Jacobs has returned to professional practice with J. L. Jacobs & Co., industrial engineers, Monadnock building, Chicago. Mr. Jacobs until recently has been engaged on special staff work with the U. S. Shipping Board Emergency Fleet Corporation.

The Miller-Holbrook Engineering Co. and the Warren Engineering Co., both of Decatur, Ill., have consolidated under the name of Miller, Holbrook, Warren & Co., Inc. The new firm will handle general municipal improvements and also specialize in reinforced concrete structures.

A. J. Hoffman of Evansville, Ind., has been elected president of the Associated Building Contractors of Indiana. Other officers elected were: Max Irmscher, Fort Wayne, first vice-president; Charles Morrow, second vice-president; J. W. Goodall, Peru, third vice-president, and C. C. Pierson, Indianapolis, secretary-treasurer.

M. B. Johnston has been elected president of the Brick Contractors' Association of Pittsburgh, Pa. Other officers are: First vice-president, Wallace F. Brown; second vice-president, George E. Sunderland; secretary, S. P. Trimble; treasurer, James H. Steel; directors, John C. Grabe, David T. Riffle, John C. Schriener, Thomas Stewart.

Obituaries

Paul Kurtz, a building contractor of Marshalltown, Ia., died Jan. 12, aged 51.

George W. Logue, a building contractor of McKeesport, Pa., died Jan. 14, aged 37.

Francis J. French, an engineer identified with the shipbuilding industry at New Orleans, La., died Jan. 8.

Harry Bates Tyler, an engineer who did extensive work in India and South America, died Jan. 8 at Worcester, Mass., aged 63. His work in South America included the construction of La Dorado Railroad, the Antioquia Railroad and the Santa Marta Railroad.

Thomas A. Alverson, for more than thirty years actively identified with the shipbuilding industry of the Great Lakes, died Jan. 5 at Detroit, aged 72. He was associated with the late Thomas Dunford in the shipbuilding and dry dock business at Port Huron, Mich. This plant is now in possession of the Foundation Company.

William A. Haven, civil engineer, died Dec. 30 at his home in Buffalo, N. Y. Mr. Haven was born in 1832. His early engineering experience was on western railroads, the Wisconsin Central, Burlington Line, of which Robert Harris was president. Later on he was engaged on the building of railroads in Vermont, and also on double tracking work for the New York Central. In 1879 he came to Buffalo in reconstruction work for the Erie Railroad, serving again under Robert Harris, who was the vice-president. During this period, 1879-1885, he also had engineering charge of the Lehigh Valley Railroad interests at Tifft farm, the building of the Buffalo Creek Railroad. When Mr. Harris was appointed president of the Northern Pacific Railroad Mr. Haven, in 1885-86, took a prominent part in building that continental railway and was later identified with the construction of the Montana Central Railroad. Returning to Buffalo in 1890 he acted as supervising civil engineer for the Erie Railroad, looking after its grade crossing interests. He also built the railroad between Olean, N. Y., and Emporium, now part of the Pennsylvania Railroad system. He was active in his profession for over 60 years.

Industrial Notes

The Merchant & Evans Co. recently began its forty-first year of continuous and successful production of mixed metals made of the so-called white metal alloys. The Philadelphia and Chicago smelting plants of the company produce annually a very heavy tonnage of all grades of solder, babbitt and newspaper metals. Large quantities of these goods have been furnished to the U. S. Government and in every instance fully met the specifications. The government also is making extensive use of the fire doors and ventilators manufactured by this company.

The sales force of The Thew Automatic Shovel Co., Lorain, O., has just concluded its annual meeting—the most enthusiastic in its history. Everyone agreed that the prospect for immediate business is exceptionally promising, particularly for road and street construction on an enormous scale. The sentiment of the country, judged by the reports of these sales representatives, is strongly for the rapid completion of a universal system of dependable highways. Foreseeing this condition, a new machine—the Type 00 Series—has been added to the Thew line of earth moving and handling equipment. This machine is equipped either as a full-circle swing shovel or crane, and is provided with either steam, gasoline or electric power. For regular shovel work it carries a ½-yard dipper. Double-drum mechanism may be furnished for clamshell or crane operation. It weighs only fourteen tons.

Second Annual New Equipment Issue

ENGINEERING AND CONTRACTING

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The *articles* in the first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering and contracting field. The *articles* in the first and last issues of each month (1st and 4th Wednesdays) completely cover county engineering and highway engineering and contracting. The *articles* in the third and last issues of each month (3rd and 4th Wednesdays) completely cover steam and electric railway location, design and construction. See the "mast head" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power

Railways and Govt. Works—3rd Wednesday
(a) Excavation and Dredging
(b) Rivers and Canals
(c) Harbors and Docks
(d) Railway Construction

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Ship Construction
(d) Miscellaneous Structures

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Our Second Annual New Equipment Issue

This—our second annual new equipment issue—comes out in more auspicious times than did the one of last January. Then the nation was just beginning to realize the tremendous task before it. Industry was being mobilized for war work, and manufacturers were commencing to devote the entire capacity of their plants to production for the Government. The general construction outlook was dismal indeed. The only consideration at that time was the successful prosecution of the war. Now, the war happily ended, every indication points to an era of tremendous activity in the lines in which our readers are most interested.

The present issue, as was the first one, is devoted entirely to brief descriptions of new equipment in the civil engineering and contracting field. The issue forms a review of recent progress and therefore should prove not only full of suggestions to most of our readers, but may well be kept as a reference catalog of the latest engineering equipment.

Some of the things described in this issue have been described in our columns during the past year, but to these have been added many other descriptions, so that the whole forms a comprehensive compendium of labor saving devices.

The advertising pages also will be found instructive, covering, as they do, a wide range of products of the latest designs.

In the past year construction operations were hampered by the scarcity, high price and inefficiency of labor. This latter consideration was in considerable measure responsible for the high cost of work. One well known highway official stated recently that in 1916 he was paying $2 per day for common labor while in 1918 the price had jumped to $4.50 and the men were 50 per cent less efficient. It is probable that there will be plenty of efficient labor available during the coming season. It should be stated here, however, that at a recent conference at Chicago, several railway officials expressed the belief that there would be extreme difficulty in securing the necessary men for their maintenance of way and other work. In any case wages undoubtedly will continue to be high, and this fact alone makes it imperative that every labor saving device should be carefully considered. In these pages—advertising as well as editorial—are brought together several hundred machines and products designed by the cleverest of engineers and inventors. America leads the world in the manufacture of machines for reducing the cost of construction. This fact, we believe, is impressively demonstrated in the pages of this issue.

Recent Developments in Construction and Engineering Equipment

HOLLOW CONCRETE POLES MADE BY CENTRIFUGAL PROCESS.

Concrete has the following advantages as pole material: Permanence, strength and availability. A novel process of concrete pole manufacture which retains these advantages has been perfected recently. By this method hollow reinforced concrete poles are produced that compare favorably with wooden poles both as to weight and first cost.

The poles are made by a centrifugal process. In this process, the first step is to build up the reinforcing cage, similar to that used in a concrete pile. The longitudinal rods are securely wrapped with hooping wire that is tied at its intersections with the rods. The cage is then placed inside a mold, which, after being securely bolted up, is filled with the required amount of concrete. The mold is then clamped in a machine that revolves it at a high speed.

The centrifugal force resulting from this rotation, causes the concrete to be uniformly distributed, and densely compacted. The surplus water contained in the wet concrete is forced to the center, and when the mold is withdrawn from the machine at the close of the operation, it runs out of the end in a clear stream. In a few minutes of rotation, the concrete is sufficiently compressed so that there remains no danger of collapse. It is so hard that a thumb nail makes but little impression upon it.

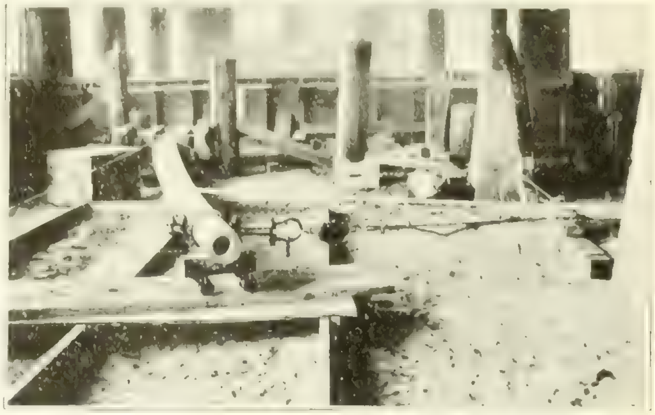
30 ft. Lighting Standard Used by Milwaukee.

The process, because of the fact that absolute control over the concrete can be exercised, lends itself to the production of ornamental effects. This fact has created a demand for such poles in the street lighting field, and there are now in operation at Chicago, Milwaukee and several smaller cities, street-lighting systems in which these poles are installed. For ornamental effects, special aggregates are used. These are given surface treatments which produces a concrete indistinguishable from natural stone. The accompanying illustration shows a 30-ft. double bracket lighting standard used in the city of Milwaukee, Wis. It has smooth natural concrete finish. The pole was manufactured and hauled 1½ miles from the factory and put in place in 96 hours.

An elaborate series of tests has been made on poles constructed by this process that confirm the assumptions made in their design. The test demonstrated an unexpected resilience of the poles, 25 and 30-foot poles deflecting 10 to 12 in., without failure, sustaining loads that have a ratio varying from two to three when compared with the designed loads. The result of a test made on a 25-ft. pole, 7 in. in diameter at the top, 13¼ in. at the butt, and weighing 1,700 lb., is given in the following table:

Load, lb.	Deflection, at top, in.	Load, lb.	Deflection at top, in.
[illegible]	[illegible]	3,000	6 3-16
[illegible]	[illegible]	3,580	7 7-16
1,000	1	4,075	9¼
1,500	[illegible]	[illegible]	10⅝
2,000	[illegible]	5,425	Broke
2,500	[illegible]		

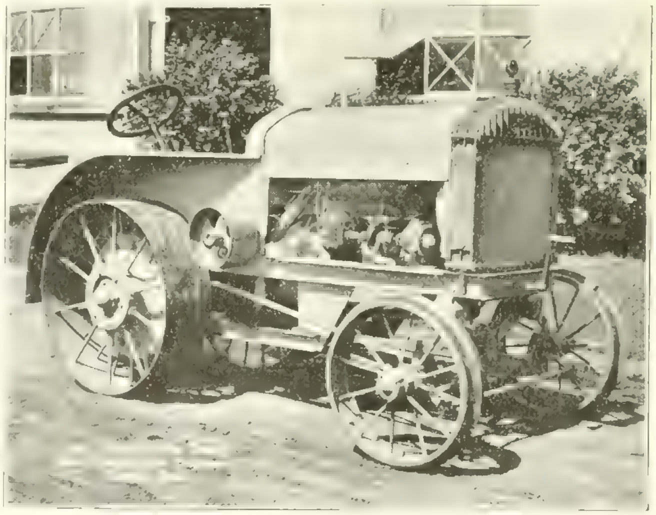
The standard poles made by this process range from 20 ft. to 40 ft. in length, and are divided into five classes—1,000, 1,500, 2,000, 3,000 and 4,000—the numbers indicating the pull in points which the poles are guaranteed to withstand. The diameter at the top of the pole ranges from 8¼ in. for the Class 4,000 to 5¾ in. for Class 1,000. The diameter at the butt varies from 10[illegible] in. for a 20 ft. Class 1,000 pole to 23¼ in. for a 60-ft. Class 4,000 pole. The approximate weight of the latter is 12,400 lb., while the approximate weight of the 20-ft. pole is 865 lb.


Testing Hollow Reinforced Concrete Pole.

The hollow concrete pole was developed by the Universal Concrete Products Company, Chicago. It is being marketed by the Massey Concrete Products Corporation, Peoples Gas Bldg., Chicago.

TRACTOR THAT IS BUILT ON SAME LINES AS MOTOR TRUCK.

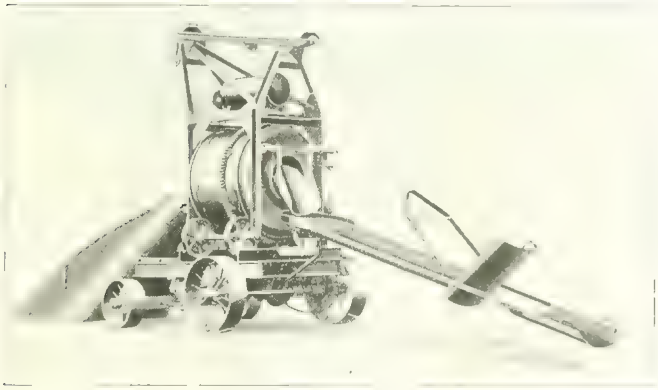
A tractor built along the same lines as a high grade motor truck and operated in the same way as a truck was brought out last year by the Dart Truck & Tractor Corporation of Waterloo, Ia. The tractor has a 4-cylinder motor with a standard system of water cooling. It has an automobile clutch and transmission similar to those of a motor car, except that direct drive is on second speed instead of on high. It has a standard motor truck steering gear, enabling turning around in a circle of 10 ft. of radius. An important feature of this tractor is the patented rear axle construction. This consists of a double reduction axle formed as a worm and enclosed bull wheel gear, giving a gear reduction of approximately 50-1. The tractor is built on the independent unit system. Each unit is easily accessible and may be easily and quickly removed without disturbing any other unit. The gasoline motor has a rating of 28.9 hp., but develops 40 hp. at 950 rpm. in block test. The speeds are: Plow speed, 2½ miles per


Dart "Blue J" Tractor.

hour; high or road speed, 5 miles per hour; low speed, 1¼ miles per hour; reverse, 1½ miles per hour. The dimensions are: Length over all, 125 in.; worth over all, 56 in.; height, 65 in.; wheel base, 77 in.; tread, c to c of wheel base, 42 in. The tractor weighs 4,500 lb.

COMPACT, SHORT COUPLED CONCRETE MIXER.

A compact, short coupled concrete mixer that can be used in alleys as well as in broad streets is illustrated. This, the No. 10 Lansing paver, is the latest addition to the concrete mixer line of the Lansing Co., Lansing, Mich. The new machine has all the strong points of the first small Lansing paver, with a bigger capacity, The extreme width of the No. 10 Lansing paver is 7¼ ft., the length with loader down but without spout, 14 1-3 ft. The height is 11 ft. The paver is conservatively rated at 10 cu. ft. dry material per batch or 8 cu. ft. wet mixed concrete. It propels itself forward or backward under its own power and will climb a 10 per cent grade. It has one speed forward and reverse. Its traction speed is 1¼ miles per hour. The standard power is an 8 H. P. gasoline engine, but a steam engine or electric motor may be furnished. The loading skip is 70 in. wide and receives two wheelbarrows at the same time. When the loader reaches discharge position the clutch is automatically released. The entire operation is controlled by one man, who is placed on a platform and has all levers within easy reach.



The No. 10 Lansing Paver.

Eight Hyatt roller bearings are used in drum rollers, main shaft and countershaft. The mixer drum is of the non-tilting type, gear driven, with cast semi-steel heads joined by heavy boiler plate steel. The main frame is 34 in. long and 45 in. wide. It has two side and five cross pieces of 6-in. channels. In the center is a 6-in. cross I-beam. There are two upper 5-in. cross I-beams for trunnion bearings. The upper frame is made of 3-in. by 3-in. by ¼-in. angle iron with 9/24-in. and 3/16-in. gusset plates. The trucks are all steel, three point suspension, with built up bolster—two 5-in. channels and plates. Both axles are round solid steel bars 2 3/16 in. in diameter. The wheels are made of steel, the front set being 20 in. in diameter with 8-in. face. There are lugs on the rear wheels which are 30 in. in diameter with 8-in. face. The tread is 66 in. The Lansing has an internal expanding, concentric ring type clutch with rings 12 in. in diameter and 2½-in face. The distributing spout, which swings 180° and is built of No. 12 and No. 14 gage steel, reinforced with 1¾-in. angle irons, is 12 ft. long and 21 in. wide. It has an adjustable pitch and is provided with gates for discharging concrete in three places.

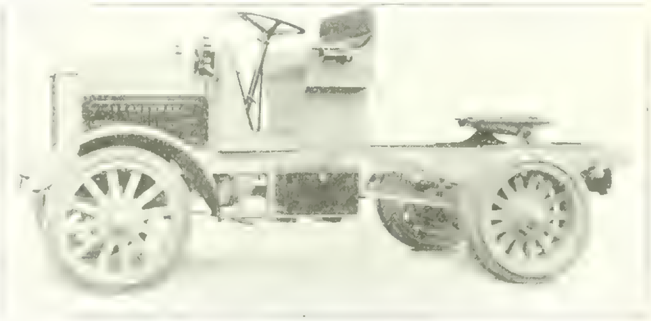
A NEW 3½-TON HEAVY DUTY TRUCK

A 3½ ton motor truck, built throughout for heavy duty service, was brought out last year by the Dart Truck & Tractor Corporation, Waterloo, Ia. In this model the transmission, being exceptionally heavy, is mounted amidship, permitting the use of a larger wheel base without too long drive shaft. Heavy universals are mounted between the transmission and motor and between the transmission and rear axle. The motor is the L-head type, 4-cylinder and 4-cycle, 4½x6 in., cast en bloc, 55 hp. at 1,400 rpm. The drive is from clutch and transmission through 2½ in. hollow drive shaft with universal joint at each end to worm driven rear axle. The wheel base is 160 in., and tread 65 in. The length over all is 243 in., width over all 86½ in. The standard size of body, 554x144 in. The capacity is 7,000 lb.; body allowance, 1,500 lb.

Dart Model L, 3½-Ton Truck.

FEDERAL TRACTORS.

Contractors and lumber dealers often find that equipment adapted to the hauling of extra long pieces of material or so arranged as to permit handling of materials in rather cramped quarters, such as alleys or driveways, would be very useful. Then, too, additional carrying power is often needed. Consequently, the Federal Motor Truck Co. decided that the tractor truck when operated with two-wheel semi, bunk or pole trailers, would be a most efficient means of taking care of these requirements. Such equipment would also hurry up construction work by reducing to a minimum the idle time of the truck, due to loading and unloading. This desirable feature would be affected by the use of two or three trailers—for instance, one being loaded, a second unloaded and the third on the way with a load or returning empty, back of the tractor. Thus one tractor would keep three trailers busy. Considering these phrases the Federal Motor Truck Co. has for the past year laid particular stress on the tractors, of which



Heavy Duty Tractor of 7-Ton Capacity

[illegible] in two sizes—one a light duty tractor, capacity 3 tons, and the other a heavy duty tractor, capacity 7 tons. These units are manufactured in addition to the complete line of [illegible] trucks, of 1, 1½, 2, 3½ and 5 ton capacity.

DEVICE FOR POLE CONSTRUCTION IN LOOSE SOIL.

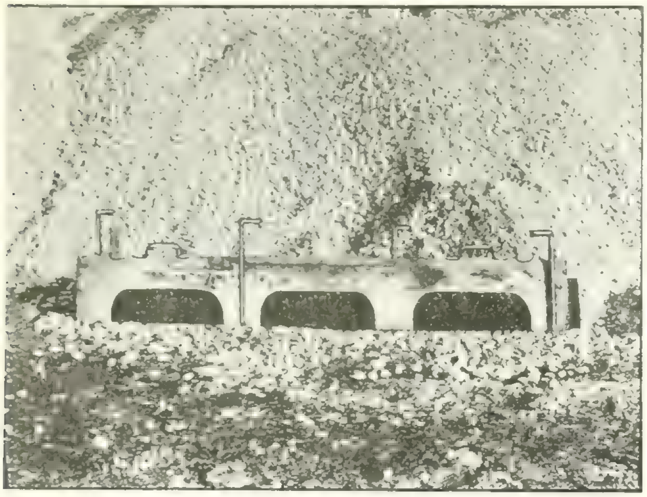
Drew Sand Barrel

The perplexing problem of quicksand and other rapidly shifting soil is often encountered in pole installation. A device especially designed to meet these soil conditions has been brought out by the Drew Electric & Manufacturing Co., Indianapolis, Ind. This is known as the Drew sand barrel. To use in placing the pole, the barrel is split [illegible] the pole. The pole is then set in place and the space between the pole and sleeve filled with concrete. When the concrete is partially set the barrel is pulled up above the ground line. Pin hinges permit instant removal. The concrete is left below in a solid, heavy cylinder.

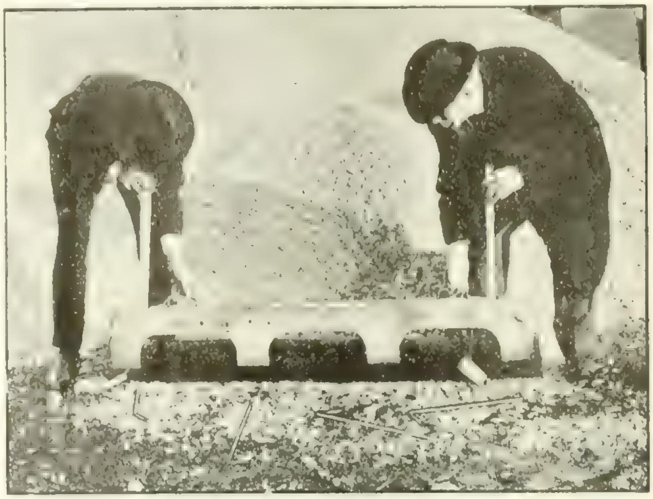
The device may be used for setting either wood or iron poles. It is now used by many large city and interurban railways, power and light companies, and telephone and telegraph systems with marked success.

DEVICE FOR INSTALLING EXPANSION JOINTS IN CONCRETE ROADS AND PAVEMENTS.

The engineer in charge of paving contracts desires to have the expansion joints placed truly vertical in a straight line across the road and for the full depth of the concrete thickness. The Contractor endorses the above and wishes further for ease to install, a simplicity to prepare for, a reduction of present costs, and a holder which can be reused often. The above possibilities, it is thought, are to be found in the elastite installing device of which the cuts shown give a fair idea of how the placing of joints is accomplished. The holder is made of sheet iron in sectional lengths, as may be desired. Openings at the bottom provide for the green concrete to engage the joint strip on each side; openings at the top allow the insertion of wood plugs to hold down the joint on the subgrade and later to permit of placing a small stick directly on top of the joint to hold it down as the holder is pulled upward and out by means of attached handles. The preliminary to provide for the joint is merely to lay the holder flat on a side, slip the joint into the opening, up end along the bottom, drive holding pins on each side and joint up the next sectional unit fitting it against the proceeding unit in a slot, and all is in readiness to place the concrete on both sides as the work reaches the joint.



Prepared Expansion Joint in Holder.

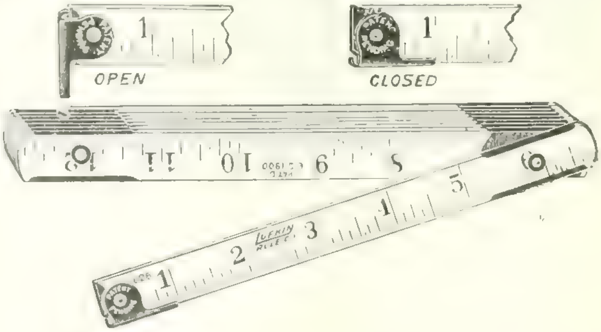


Method of Raising Joint Installing Device.

This installing device has been perfected by The Philip Carey Co., Lockland, Cincinnati, O., the manufacturers of Elastite expansion joint. The company intends to license contractors to make and use this installation device and method without cost to the contractors.

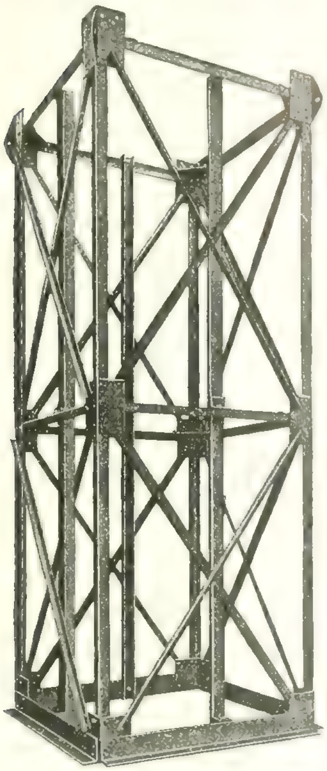
FOLDING HOOK ATTACHMENT FOR SPRING-JOINT RULES.

An attachment for spring joint rules that facilitates the taking of measurements out of arm's reach has been brought out by the Lufkin Rule Co., Saginaw, Mich. It consists of a small substantial hook fitted to the first end of the rule. This hook is so attached that it will fold up and remain flush with the edge of the rule making it in appearance and for use the same as ordinary rules without the hook.



Patent Folding Hook for Spring Joint Rule.

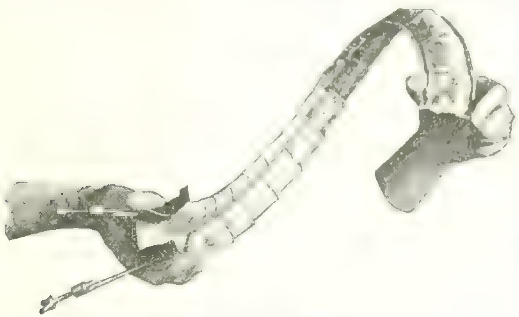
STEEL TOWERS FOR CONCRETING.



Section of Ransome Steel Tower.

Steel towers that are claimed to strike the right medium between the tower which is too heavy for practical purposes and the tower which is so light that it cannot be held from twisting, have been brought out by the Ransome Concrete Machinery Co., Dunellen, N. J. It is needless to point out that errors in both directions have been quite frequent in the construction field in the past. The towers are built in 15 ft. lengths, which experience has proven is an economical and practical length both in shipping, assembling and dismantling. Three types of towers are built—Light towers for bin load only; heavy towers for boom plants or long runs of continuous line chutes; sliding frame towers for boom plants equipped with sliding frames for the bin and boom. A contractor can readily decide which tower is best suited for his average job, but if he is doing a variety of work the sliding frame tower will be economical in the long run.

ADJUSTABLE MOLD FOR MAKING JOINTS IN VITRIFIED PIPE.



The Flex-Form.

An improved method of making joints by a process of pouring the joint material was developed in 1918. The apparatus used for the purpose is the flex-form joint mold manufactured by the Wyatt Engineering Co., 1672 Summit Ave., Columbus, O. The experiments which led to the perfection of this device were carried on jointly by the Wyatt Engineering Co. and the Vitrified Pipe Manufacturers' Association. The pouring of joints of bituminous joint compounds is not new; heretofore the familiar snake runner or asbestos runner has been used to retain the hot joint material within the bell of the pipe during the pouring. By the Flex-Form method room is provided for a bevel of joint material in front of the lip of the bell which is a safeguard against leakage. During the actual pouring this bevel provides for greater volume of the joint material for its entrance into the bell, from all sides instead of confining the stream of hot compound to the narrow annular space of the bell. Where the hot material is thus confined to the annular space there is a tendency to chill before the space is completely filled, which is obviated by the Flex-Form.

In the improvement of Portland cement joint practice the Flex-Form has proved very useful. The old, hand-troweled cement joints were very rarely impervious when completed, and even when made with the utmost care there was a tendency for the joint of the cement to crack during the succeeding manipulation of the pipe in making the ensuing joint. The Flex-Form method of making cement joints is to pour the cement in the form of a grout about the consistency of thick cream; the resulting joint is remarkably dense, neat and compact, and immune to seepage at ordinary pressures. By adding a small percentage of waterproofing to the cement the joint can be made thoroughly impervious at pressures far in excess of those that have been demanded for sewerage practice in the past.

Pouring the Joint.

The Flex-Form mold consists of a series of overlapping sheet metal scales or plates strung upon light steel cables with devices for clamping around the pipe and the funnel for the introduction of the joint material. It has the merit of holding the pipe in perfect alignment during the setting period.

Recent experiments by the inventor, DeWitt H. Wyatt show a Flex-Form joint of bituminous compound to be capable of withstanding an internal hydraulic pressure of 55 lb. per square inch without the slightest seepage. The device is made in sizes up to and including 24 in.

BOTTOMLESS POWER SCRAPER FOR HANDLING LOOSE MATERIAL.

To meet the demand for a light and inexpensive machine for handling loose materials, such as coal, sand, gravel, etc., Sauerman Bros., 322 S. Dearborn St., Chicago, Ill., introduced their Type "C" power scraper during the past year. This type of scraper is not as heavy as the Sauerman standard type scraper with the hinged runner frame, but it is of substantial design and construction and will give the maximum service on work for which it is intended. It is especially recommended for reclaiming material from stock piles.

The scraper is bottomless and is usually built with a top plate extending either over the entire top or only part of the top, and with two side plates. The front of the scraper is reinforced by means of a bar extending over the top and down on the side plates. Curved renewable runners, which can readily be replaced when worn out, are bolted to angle irons at the bottom and rear end of side plates. The cutter edge and back plate are pivotally connected at the lower and rear end of side plates and can be set at any angle and the cutter edge can be set lower if the conditions so require. This makes it possible to obtain the greatest efficiency by adjusting the angle of digging to the condition of the material.

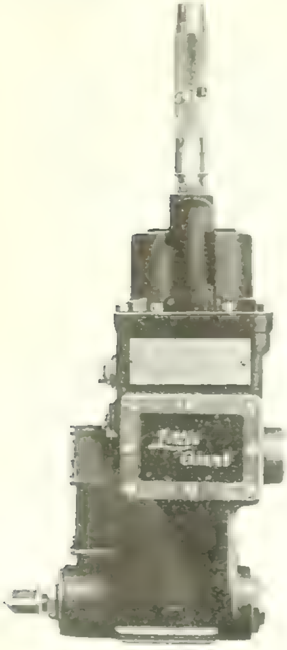
The Type "C" scraper is made in sizes of ⅓, ½, ¾, 1, 1½, 2 and 2½ cu. yd. The daily handling capacities vary greatly, depending upon distance material is to be conveyed and other conditions of the work.

To operate, the scraper is simply pulled back and forth over material to be handled. A double drum friction hoist supplies the power, the front drum operating load cable and rear drum the "pull back" cable. All the cables operate over elevated guide blocks. An installation of the Type "C" power scraper made this year for the Construction Materials Co., South Chicago, Ill., is illustrated. This is a typical installation for loading sand from pit or storage piles to cars.

Power Scraper at Yards of Construction Materials Co., South Chicago, Ill.

LITTLE GIANT CORNER DRILL.

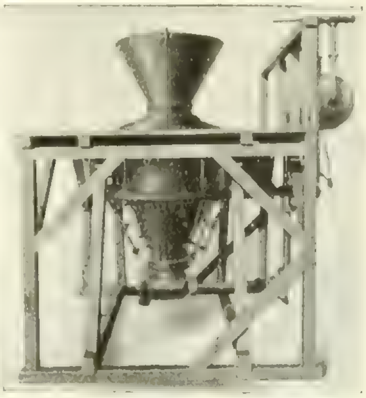
A drill designed to overcome the objection arising from the intermittent action of ratchet levers in the rotation of the spindle is illustrated. In this drill steady, uninterrupted revotion of the drill spindle is accomplished by means of a train of gears, retaining all the advantages of the ratchet type and permitting the drill to be used in the same narrow space, within 1 7/16 in. of the end wall or corner. The power of the motor is transmitted to the spindle without vibration, resulting in a steady, even pull with minimum wear and tear on the machine itself. In the stub-tooth gears which are employed, the root of the gear tooth is much thicker than in the standard involute tooth. The tooth itself is shorter, hence it has a harder pull. The special alloy steel used in these gears makes them practically indestructible. The drill is known as the Little Giant corner or close quarter drill. It is manufactured by the Chicago Pneumatic tool Co., Chicago.



Close Corner Drill.

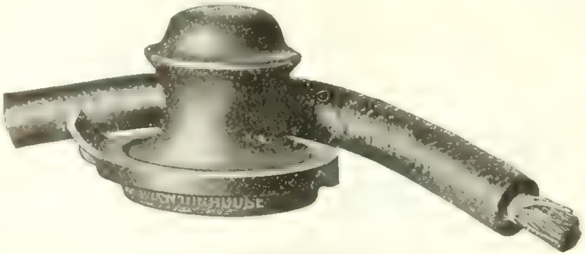
PNEUMATIC MIXER AND PLACER.

A pneumatic mixer and placer that has proven its economy and durability on many jobs is illustrated. One of the most notable of the jobs was the lining of the Coulter Tunnel on the Pittsburgh & Shawmut R. R., without interrupting train service. Concrete to the amount of 10 yd. per hour was mixed at one portal of the tunnel and forced through 6 in. steel pipe to a maximum distance of 2000 ft. as the work was gradually extended within the tunnel. At the end of the steel pipe a 30-ft. length of rubber hose was connected so that it could be deflected to any part of the circumference of the cross section of the tunnel in order to deliver the concrete into the form behind the bulkhead. In operation the aggregates when placed in the mixer were subjected to rapid and severe ebullition by the introduction of many high velocity jets of air and water. Through the medium of a pressure sealing mechanism and under the pressure of air and water the mixed concrete was forced through a pipe conveying system as crete in the forms. This machine—the Ransome-Canniff pneumatic mixer and placer—is manufactured by the Ransome Concrete Machinery Co., Dunellen, N. J.


Ransome-Caniff Mixer.

ARMORED CORNER INSULATOR FOR FEEDER CABLES.

A new Pittsburgh-type corner insulator, for securely holding feeder cables on curves, is being marketed by the Westinghouse Electric & Manufacturing Co. It is provided with a special collar or retaining ring for use where the curve is slight and the cable likely to slip off an ordinary insulator. This collar has an extended lip which curves up around the cable and keeps it in the groove regardless of the angle at which the cable turns. This eliminates the necessity for tie wires and saves time in erection. This collar is free to move on the insulator cap, so that after the insulator is screwed to the pin, the collar may be turned until the cable seat is in the proper position best to support the cable. For sharp curves, the insulator can be used without this collar, as the deep side groove holds the cable firmly in position. These insulators are made of moulded insulation surrounded by a sherardized malleable iron cap. They are made with a 1-in. pin hole and are furnished in two sizes for feeders of 500,000 and 1,000,000 circular mils, respectively.



Corner Insulator With Collar.

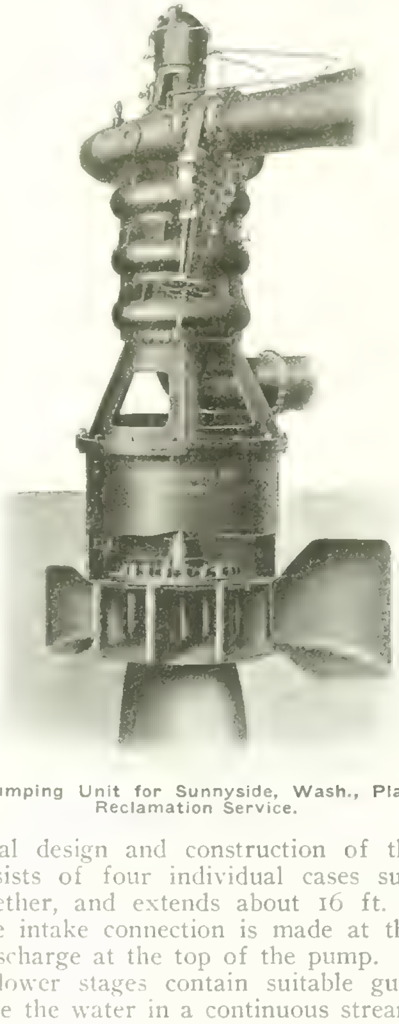
COMBINED VERTICAL SHAFT TURBINE AND 4-STAGE PUMP OF GRANDVIEW IRRIGATION DISTRICT, SUNNYSIDE UNIT, YAKIMA PROJECT, WASHINGTON.

This plant is located at the head of the Mabton Feeder Canal, approximately two miles from the town of Grandview, on the Sunnyside main canal, and contains one direct connected turbine-driven pumping unit and two motor-driven units. All three units receive water from the Sunnyside main canal. The water which is used for operating the hydraulic turbine is discharged into the Mabton Feeder Canal, while the water which passes through the pumps is discharged through wood-stave pipe lines to high line canals.

The net power head under which the hydraulic turbine operates is 21 ft., while the working head against which the pump operates is 78 ft. The water is discharged through 6,000 ft. of 40-in. inside diameter wood stave pipe, the maximum velocity in this pipe being 3 ft. per second. The horizontal center line of the turbine unit is placed 7 ft. above tail water and 4 ft. below the floor of the pump house. The turbine is installed in a closed concrete scroll and discharges through a concrete elbow shaped draft tube. The turbine consists of a vertical shaft 30 in. type "O" Smith wicket gate unit which under 21 ft. head develops 214 Brake H. P. at 225 rpm. The maximum discharge of the turbine is 110 cu. ft. per second, but at point of best efficiency it discharges approximately 95 cu. ft. per second. The design of the turbine is such as to give unusually high efficiency over the complete range of gate from half to full opening.

During certain seasons of the year the water used by these plants contains a considerable amount of fine sharp silt, which is very destructive to the submerged wearing parts of the turbine and pumps, and this condition was given special consideration in the design of the machinery, and suitable provision made for protecting the parts against wear, and also for renewing with minimum expense and inconvenience such parts as could not be sufficiently protected. This design incorporated the use of a cast iron speed ring or guide ring, which was imbedded in the concrete scroll. This speed ring has stationary guide vanes which direct the water in towards the turbine runner. This speed ring was made very heavy and strong, and on account of the slow velocity of the water its action would be in no way detrimental to it. Inside this speed ring are placed the top and bottom plates between which the wicket gates of the turbine are located. These top and bottom plates are provided with removable steel wearing plates which can be easily renewed. The wicket gates are of cast steel, and the gate stems or spindles are cast integral with the wickets, and the gate spindles move in bronze bushed bearings in the top and bottom plates. The gate stems on the upper end extend through stuffing boxes in the top plate, and all the gate mechanism is located on the top plate where it is in plain view of the operator for the purpose of inspection and lubrication. This design leaves practically no movable part of the turbine in the water except the cast steel wickets, and the turbine runner. There is no step bearing in connection with the turbine unit, as it is of the suspended type and the weight of the rotating element including the turbine runner, the turbine shaft, and the downward thrust of the turbine, as well as the rotating parts of the pump unit are supported by means of an oil bath thrust bearing placed on top of the pump unit, the turbine and pump being so designed as to support this bearing and the load which it carries. The top plate of the turbine is cored and the water drained from between the runner and the top plate down through the guide vanes of the speed ring, these guide vanes being cored out for that purpose, which is a design patented by the builders of the turbine. The speed ring and the extension ring above it (known as the pit liner) are so designed as to support the pump unit. The gate operating mechanism of the turbine consists of hand wheel and worm gearing so arranged that the turbine gates can only be moved very slowly, thus giving fine adjustment and avoiding water hammer due to the long discharge line.

The pump is of the vertical shaft 4-stage type, with 30 in. diameter intake and discharge openings, having a capacity of 7,500 gal. per minute, against 78 ft. total head, and requires approximately 212 H. P. maximum.



Combined Pumping Unit for Sunnyside, Wash., Plant of U. S. Reclamation Service.

The general design and construction of the 4-stage pump consists of four individual cases substantially bolted together, and extends about 16 ft. above the floor. The intake connection is made at the bottom, and the discharge at the top of the pump. The three initial or lower stages contain suitable guide vanes, which guide the water in a continuous stream through the pump. These guide vanes form a part of the pump casting. The upper stage or discharge case of the pump is of spiral or volute form increasing to 20 in. diameter where it connects to the discharge line, an outside screw rising stem 20 in. gate valve being located between the discharge flange of the pump and the pipe line. Steel wearing rings around the suction inlets of the pump impellers, also wearing rings in the pump proper, are provided for the purpose of insuring easy and inexpensive renewal of such parts as are affected by the silt in the water.

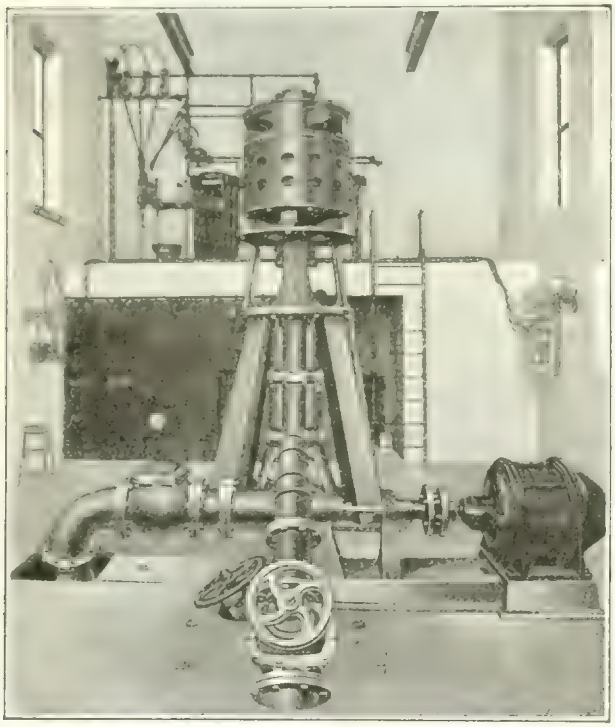
The hydraulic turbine and accessories, together with designs of the concrete scroll and concrete draft tube, were supplied by the S. Morgan Smith Co., of York, Pa., while the pump unit was furnished by the Byron Jackson Iron Works, Inc., San Francisco, Cal. The accompanying illustration shows the combined unit.

A very similar combined unit is now in course of construction by the two companies above mentioned for installation at the Price Stub pumping plant of the Grand Valley Project of U. S. Reclamation Service in Colorado, where the net head on the turbine is 17 ft. and the water is supplied to the turbine through a 60 in. diameter penstock 150 ft. long. The turbine will be a 45 in. type [illegible] H. P. at 240 revolutions per minute, the maximum water for power purposes being 77 cu. ft. per second, and the normal 70 cu. ft. per second. The pump will operate against a total head of 31 ft., including friction, and deliver 13,000 gal. of water per minute through 350 ft. of 36 in. diameter discharge pipe.

The pump will have 24 in. diameter inlet and discharge openings. This plant will be located on the Government High Line Canal, approximately two miles from the town of Palisades, Colo., on the Denver and Rio Grande Railroad.

HIGH AND LOW PRESSURE PUMPING UNIT.

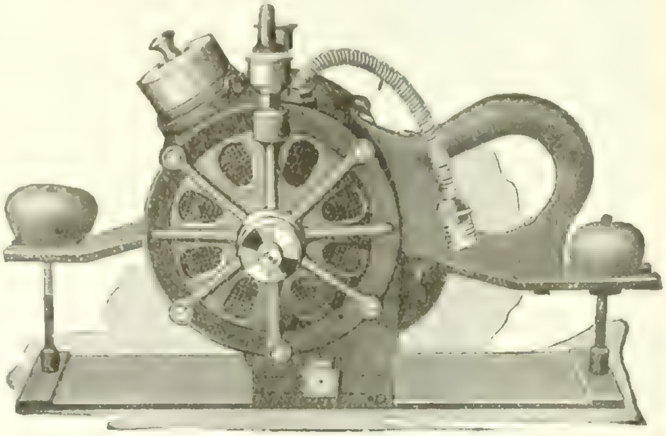
The City of Rockford, Ill., has recently had installed at the Rulin Park Station in Well No. 8, a deep well turbine pump which, in addition to pumping directly into the mains against main pressure, is also equipped with a horizontal involute booster pump for fire pressure. The vertical turbine is driven with a 150 H. P. vertical motor and the booster pump with a 25 H. P. horizontal motor. The illustration gives an idea of the layout. Ordinarily the vertical pump only is operated, by-passing the booster. When it is desired to use the installation as a fire pump, the booster is cut in. This installation handles over 2,500,000 gal. of water per day, total head pressure being 124 lb. or 285 ft., and in case of fire the pressure is increased to 149 lb. or 343 ft. There is no resultant overloading of motors when the booster is cut in, the installation being self-balancing and the only effect being to increase the pressure about 25 lb. The unit is equipped with remote or automatic control, all safety and protective devices, automatic oiling system, and requires practically no attention. The vertical turbine was manufactured and the entire equipment installed by the Layne & Bowler Co. of Memphis, Tenn. The pump is a 5 stage 20-in. turbine, which is placed 105 ft. below the base plate with 35 ft. of suction pipe. The head is designed for heavy lifts and the downthrust occasioned by the weight of shafting, impellers and discharging water column is carried on a full floating oil balance fluid bearing, this bearing being actuated by means of a small auxiliary pressure pump which maintains a uniform pressure on the bearing pistons consistent with the downthrust encountered, the entire operation being automatic.



Pumping Unit at Rulin Park Station, Rockford, Ill.

LABOR-SAVING POWER-OPERATED PLANER.

A portable electric planer, operated like an ordinary carpenter jack plane, and stated to be capable of planing from 500 to 700 sq. ft. per 8-hour day, with one man, has been placed on the market recently. The planing is done by rotary cutting blades (making about 3,600 r.p.m.) operated by a small light motor directly attached to the machine. Each forward movement of the planer produces a smooth surface up to 4 in. wide. Flat or curved surfaces are planed with equal ease, since the base is adjustable to conform to the surface worked upon. The planer was devised by Capt. F. L. Forward while engaged on a contract for constructing 110 ft. submarine chasers for the Government. A test on this contract showed that it took 15 men at $4 per day, 12 days to plane the sides of one of the 110 ft. chasers by means of the ordinary jack plane. The same work was done in 4 days by two men with the power planer at a total cost of $48 including power. This planer is manufactured by the Universal Planer Co., Inc., 16 Exchange Place, New York City.



Power Operated Planer.

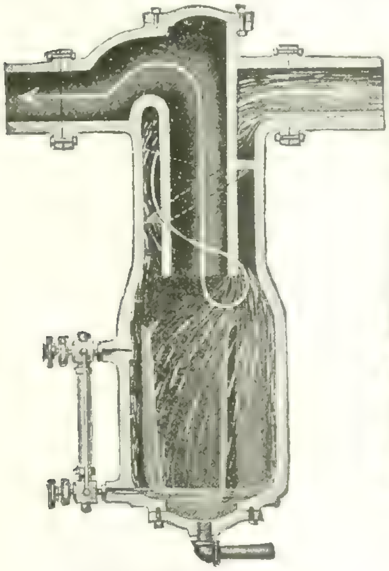
NEW P. & H. BACKFILLER OF DRAGLINE TYPE.

A backfiller of the dragline excavator type has recently been placed on the market by Pawling & Harnischfeger Co., Milwaukee, Wis. The machine is designed to backfill all trenches ordinarily cut with trench excavators for water, gas or sewers. The general dimensions of the backfiller are: Out to out of rear wheel, 5 ft.; wheel base, 6 ft. The weight in working order is about 4,000 lb., and the propelling speed is approximately 1½ miles per hour. A scraper, 4 ft. wide, of Fresno type, is furnished with the machine. The car body is built up of two 6-in. channels running fore and aft and cross-connected by means of 6-in. channels where necessary. The machinery base, consisting of two 6-in. channels, is mounted on top of these beams and efficiently connected to them. The main machinery consists of one intermediate shaft, chain connected to the engine, and one drum shaft, gear connected to the intermediate shaft. The drum runs loose upon the shaft and is connected thereto by means of a cone clutch 13-in. diameter by 2-in. face, lined with asbestos lining. The drum is 7-in. diameter for ⅝-in. steel rope. The intermediate shaft is connected to the engine by means of a high-speed roller chain of 1-in. pitch. A cone clutch is provided on the intermediate shaft enabling all machinery to be placed out of action. A steel bevel pinion on the end of the intermediate shaft is provided with two semi-steel bevel gears on the propelling shaft. These gears are provided with clutches, by means of which propelling motion is obtained in either direction. The steering machinery is mounted under the car body and is operated by a worm and worm wheel, which is self-locking. Connection between this shaft and the front axle is by means of chains. The steering shaft is hand operated, a large wheel, with handle being provided for this purpose. The operating levers are located at the rear of the machine and so grouped that they can all be reached from one position. The machine is driven by a 6-H.P., single cylinder vertical, hopper-cooled engine, running at 450 revolutions per minute, and connected to the machinery by means of a high-speed roller chain.

The trade name of this latest addition to the excavating equipment line of Pawling & Harnischfeger is the "Tom Thumb." As indicated by the name the new machine is smaller than the well-known P. & H. boom type backfiller.

SEPARATOR FOR REMOVING WATER FROM COMPRESSED AIR.

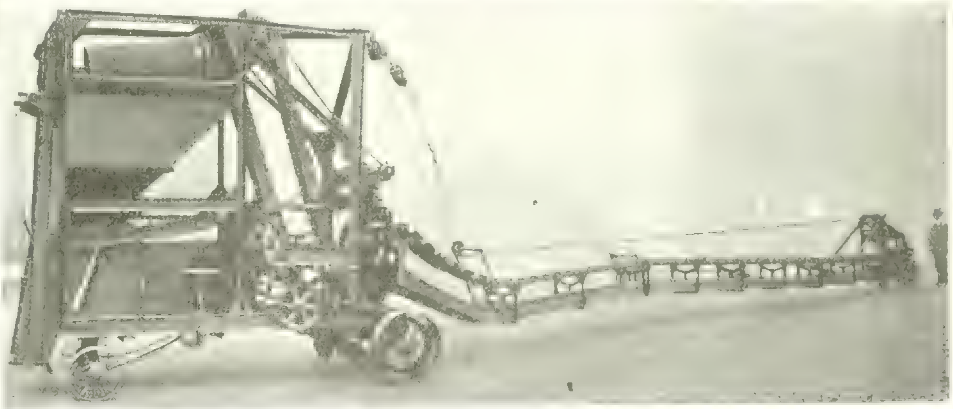
In connection with the operation of pneumatic tools any water which is in the compressed air supplied to them occupies valuable power space in the cylinders of the tools, thereby decreasing their efficiency and sooner or later resulting in damage to the tool itself, due to the constant internal hammering action of the water. A device for mechanically removing water from compressed air has recently been placed on the market by the Griscom-Russell Co., 90 West St., New York. This separator utilizes centrifugal force to remove the water from the air. As the air and water enter it they pass through a helical path formed about a central cylinder, resulting in a swirling motion of the entire mass. As water is several hundred times heavier than air it is thrown out of the curving air current, and against the walls of the separator, which it meets at an angle without any spatter or splash and slips smoothly along until it reaches the receiver space at the bottom. Here the motion is retarded by vanes in order to permit drainage of the accumulated water. It is stated that the resulting separation is complete, with practically no pressure loss. The separator is made of close-grained cast iron, suitable for a working air pressure not in excess of 200 lb. per square inch, is simple in construction, has no movable parts and it is claimed will operate indefinitely with a minimum of attention.


Stratton Air Separator.

LABOR SAVING MACHINE FOR LOADING CONCRETE MIXERS.

A mixer loader that is claimed to effect 75 per cent reduction in the manual labor of wheeling and shoveling concrete aggregate has been developed by the Stamp Loading Machine Co., 76 Menomonee St., Milwaukee, Wis. The machine is a one-man controlled conveyor, carrying the aggregate from ground storage piles and automatically loading and measuring the sand and stone into the skip, in any desired proportion. It consists primarily of a single conveyor into which both sand and stone are shoveled, having its inward end upwardly inclined and discharging into an elevator. The elevator discharges into a rotary screen, the sand falling through this screen into a sand storage bin and the stone passing over into a stone storage bin. Below these storage bins is a measuring bin having a sand and stone compartment. These compartments are adjustable to suit the proportion of aggregate desired and when once set will measure out exactly the same amount every time a batch is discharged into the mixer skip.

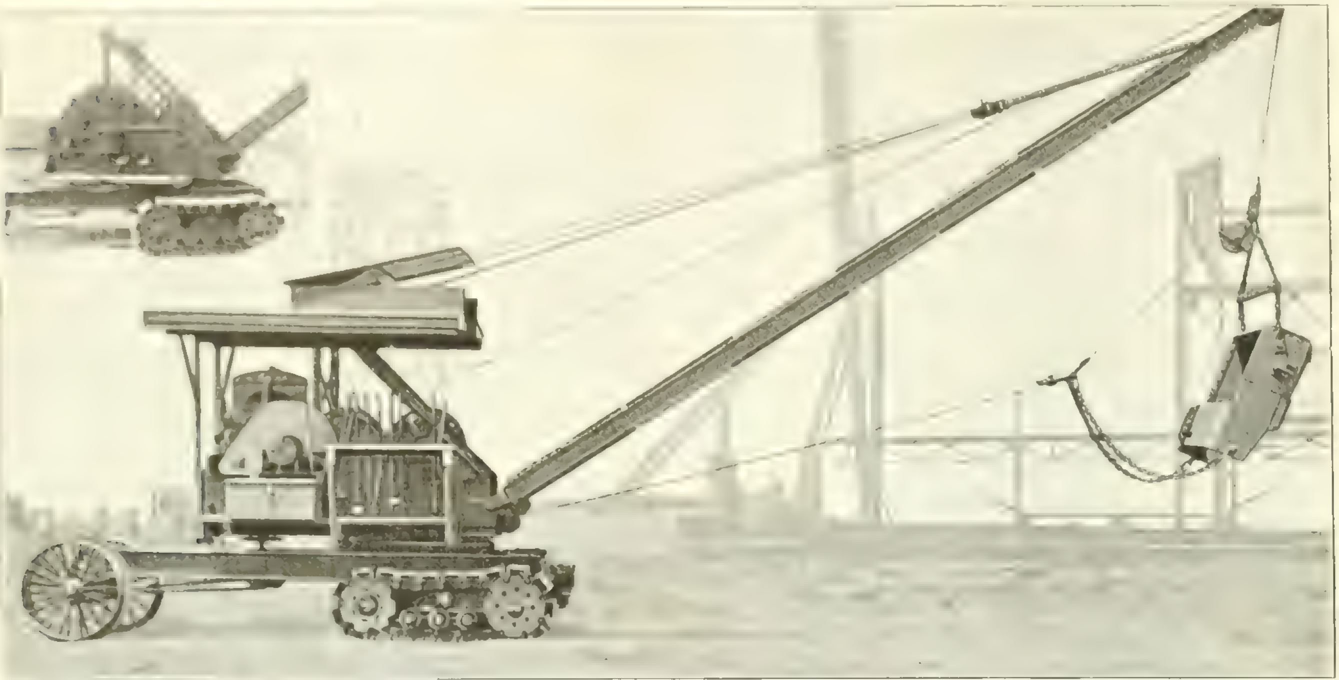
This measuring bin is hinged to the top of the framework and swings outwardly and over the mixer skip. When in out-position, the door automatically opens and the measured batch is deposited into the mixer skip. The cement is not handled by the machine and is placed into the skip as under hand loading conditions.


Mixer Loader That Screens and Proportions Aggregates.

The conveyor is 50 ft. long and of a special type which carries the material on the lower strand. The point to which material is delivered is only 7 in. above the ground level and therefore at the base of the pile of material which can be scooped into the conveyor with a shovel. A forward and reverse self-propelling mechanism is provided and when moving, the conveyor is elevated by means of a set of cables and a pair of wheels at the outer end. The conveyor can be swung in an arc of about 180°, thus enabling it to turn corners with ease and allowing it to move as easily as a mixer. The time required to lift the conveyor and move ahead 10 to 15 ft. is stated to be only about [illegible] minute.

DRAG LINE EXCAVATOR AND BACK FILLER HAS MANY USES.

A small portable drag line machine of wide adaptability has been placed on the market by the Pawling & Harnischfeger Co., Milwaukee, Wis. The machine can be used for backfilling after the largest size of trench excavators, for general drag line work and for handling screenings, crushed rock, etc. It also can be used as a portable locomotive crane. In the latter capacity it can lift 3,500 lb. at 30 ft. radius, and can be used for unloading materials from cars, placing pipe in trenches, pulling piles, etc. This backfiller and dragline excavator is regularly equipped with a 40-ft. boom and 6-ft. wide self-acting backfilling scraper. Boom extensions for increasing the length of boom up to a total of 50 ft. can be furnished at additional cost for backfilling only, if required. The standard machine with 30-ft. boom will also handle either a ½-yd. drag scraper bucket, or a ½-yd. clam shell bucket. These parts with their attachments are furnished at additional cost. The machine weighs 13 tons and has a traction speed of 0.85 mile per hour. It is driven by a 4-cylinder vertical 30-HP. motor of the internal combustion type. The corduroy bearing surface is 18 in. by 5 ft. 6 in.



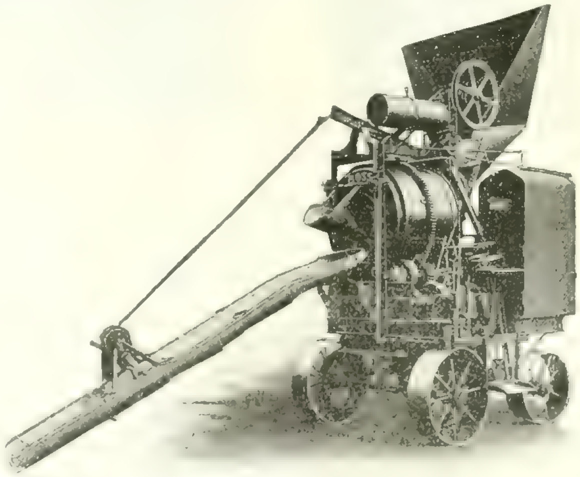
P. & H. Class 205 K.C. Dragline Excavator and Backfiller Equipped With ½-Yard Page Scraper Bucket on 30 Ft. Boom.

NEW WYE LEVEL.

An engineers' wye level having a number of new and improved features was brought out in 1918 by the Warren-Knight Co. of Philadelphia, makers of "Sterling" surveying instruments. In the construction of this instrument, a hardened steel center is fitted in a socket of annealed iron, and is secured to a heavily ribbed level bar of hard bronze. Replaceable bushings are provided into which the leveling screws are fitted, the complete leveling head being so designed as to insure an absolutely non-cramping center. The telescope is set low in the wyes, and the entire instrument is extremely rigid and well balanced. The reflecting mirror may be instantly detached or used on either the right or left side of instrument, as desired. By means of a special lens combination, a minimum focal range of telescope of about 7 ft. has been obtained, without sacrificing its unusually clear and brilliant field of view on long range. Suitable dust guards for focusing slide and eyepiece are provided, and the bearing surfaces of the telescope are of hardest bell metal. A new type of lock screw for securing the wye clips is used. The clamp and tangent screws rotate with the bar, and are always in the same relative position to the operator. Suitable adjustment is provided on the tangent screw socket for taking up wear.

HIGH DRUM "NON TIP" CONCRETE MIXER.

Improved types of Boss pavers have been brought out by the American Cement Machinery Co., Inc., Keokuk, Ia. These machines—known as Lincoln Highway pavers, are built practically entirely of steel One man handles them—all operating levers are banked within easy reach. They offer the contractor his choice of gasoline, kerosene, steam or electric power, and the gasoline and kerosene machines are stated to have demonstrated the fact that they are as reliable as steam.

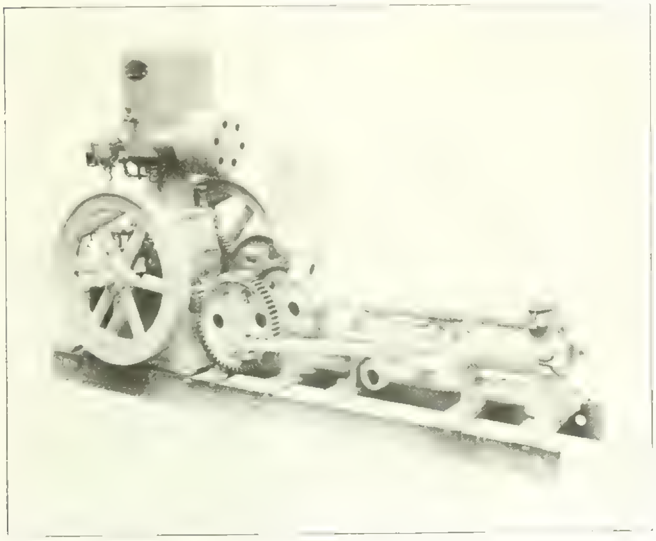


Lincoln Highway Paver.

Lincoln Highway pavers are all built with high drums —bottom of discharge spoon 6 ft. from the ground. Danger of tipping is eliminated by specially wide track and wide tires. The chute is sectional, with three gates, and allows dumping of concrete right up to the paver.

NEW FORCE PUMP FOR CONTRACTORS.

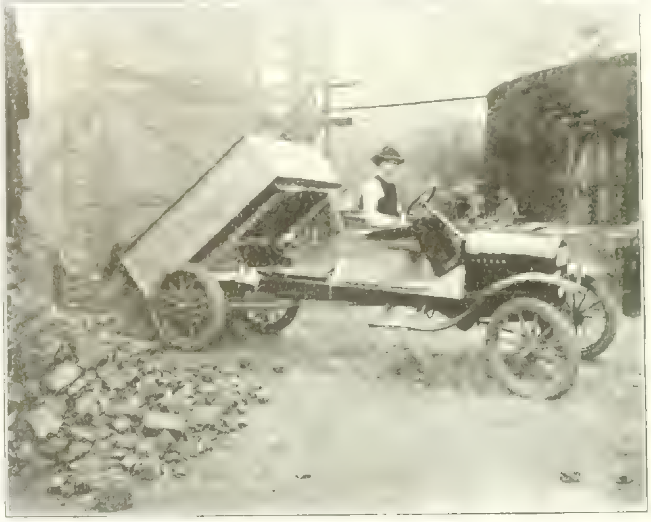
A new force pumping outfit especially designed and constructed for road contractors was developed last year by the Barnes Mfg. Co., Mansfield, O., and will be placed on the market this spring. The new pump is of the outside packed type and has no brass lining or leather packed piston. In place of the latter feature there are two iron plungers horizontally opposed and working alternately in and out of the two cylinders. Each plunger passes through a stuffing box containing packing which is held in place by a gland. When water starts to seep out around the plunger, the efficiency and capacity of the pump is maintained by tightening the gland. When the packing around each plunger is worn out, as shown by the fact that the gland has been tightened as far as possible, it is stated to be but a matter of 15 minutes to remove the gland, repack the plungers and replace the gland. As the pump is of the displacement plunger type, no brass lining is needed in the cylinders and drawing sand into the pump will not injure it, although precautions should be taken to pump clear water only. The valves of the pump are of the wing type, with bevel seats, both of solid bronze. The valves are immediately accessible, as well as the interior of the cylinders, after unbolting their respective valve port caps and cylinder heads. The working parts of the pump coming under an alternating load, such as the crossarm (head) and connecting rods are of cast steel and malleable iron, respectively, giving great strength where needed and insurance against sudden breakage. The gears and pinions are machine cut, the latter of steel. The design of the pump permits of mounting the power end to end with the pump on channel steel skids, giving a light and strong form of base, thereby increasing the portability of the outfit. It is also noticeable that the pump is close to the ground, i. e., it has a low center of gravity, a very desirable feature for portable work.



New Outside Packed Pump Especially Designed for Road Work.

AUTOMATIC DUMP BODY FOR SMALL TRUCKS.

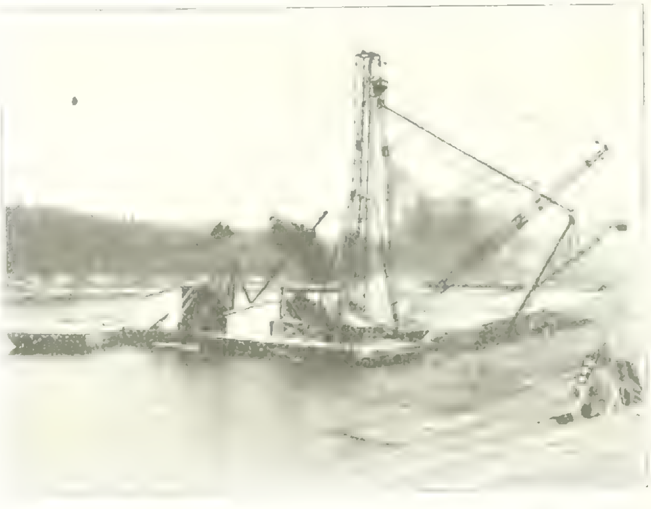
An automatic dump body designed for attachment to a Ford 1-ton truck is shown in the accompanying illustration. The dumping is accomplished simply by releasing the latch, the body being instantly restored to the horizontal position upon disposal of the load. This accomplished by the use of cams on inverted V-shaped racks, which are fastened to the chassis by bolts passing through the standard holes in the rear cross member of the chassis. At the front they are located on brackets which are in turn fastened to chassis frame by means of U-bolts. The eccentric load devolving upon these brackets is taken care of by means of a rod which fastens both brackets together at points above the frame. In this manner all the strain of eccentric loading is relieved from the attaching U-bolts. It is possible to arrest the body movement at any angle and hold it there. In the same manner also may the body be so retarded that the final dump is accomplished easily and without excessive strain to any of the parts. In connection with this feature road material, such as crushed rock, gravel, cinders, etc., can be spread by holding the body at the proper angle and opening the tail gate at that point. A device attachable to the tail gate can limit this opening so that only a certain thickness of material will pass out the gate. The body is manufactured by the Anthony Co., Inc., Streator, Ill.



Automatic Dump Body Attached to 1-Ton Truck.

PORTABLE GRAVITY PLANT FOR CONSTRUCTING CONCRETE PAVING ON RIVER BANKS.

Excellent results in the construction of revetment on the banks of the Mississippi River have been obtained by the U. S. Engineers Office, Vicksburg, Miss., with the portable gravity concreting outfit shown in the illustration. This plant is stated to have placed 182 squares of concrete pavement on its first day of



Portable Gravity Plant Equipment Employed by U. S. Engineer's Office, Vicksburg, Miss., for Mississippi River Revetment Work.

[illegible] The [illegible] for work of this kind on the Mississippi River was 105 squares. The steel tower is 104 ft. high and the steel boom is 80 ft. long. The roller hoist bucket has a capacity of 34 cu. ft. and the hopper a capacity of 54 cu. ft. The special boom chute has a length of 80 ft. and the counterweight chute is 50 ft. long. The outfit is carried on a 38x120 ft. barge. The gravity plant was made by the Insley Mfg. Co., Indianapolis, Ind.

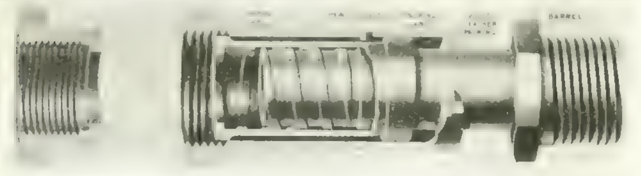
COMBINATION ELEVATING REAR DELIVERY AND SEMI-DUMP TRUCK BODY.

A combination elevating rear delivery and semi-dump body for motor trucks has been placed on the market by the Thomas Wright Co., Jersey City, N. J. The arrangement gives a combination of three bodies in one. In the service-dump condition the body can be used for hauling construction material, such as sand, gravel, brick, brokenu stone, asphalt, etc. In the full elevated position it can chute coal to a distance of 20 ft. or more. This makes it possible for a contractor in his slack season to rent his truck to a coal dealer, who can use it as advantageously as though it had been made for his particular business. The bodies are made to fit the chassis to which they are to be attached and the requirements of the individual user. They are made in capacities from 2 tons to 8 tons and they can be operated by power hoist or hand hoist.

Three In One Truck Body.

NEW EXPANSION COUPLING.

A new expansion coupling designed by Mr. E. H. Ford, of the Ford Meter Box Co., Wabash, Ind., is shown in the accompanying illustration. This coupling, while deyised primarily for the purpose of connecting water meters into straight line pipes, may be used in any place where flexibility is required in water, gas or steam piping. It is made now in three sizes, for 5/8 in., 3/4 in. and 1 in. [illegible] in connection with 1½ in., 3/4 in. and 1 in. pipe. No special tools are required for its installation. The coupling is composed of only three parts and the three sizes mentioned provide expansion ranges of 5/8 in., 7/8 in. and 1 in. respectively. Sample couplings have been subjected to test pressure of 300 lb. without showing leak.



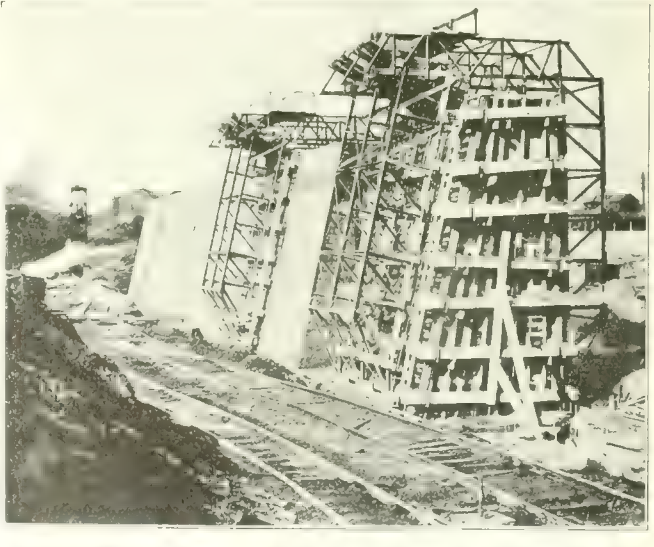
Details of Expansion Coupling.

NEW TYPE OF TRAVELING FORM HAS NO TIE RODS.

A new type of traveling "Blawform" was used by Stone & Webster in the construction of concrete walls for the Brier Hill Steel Co., Youngstown, O. A feature of the new type is the elimination of the tie rods (spaced about 5 ft. apart horizontally and vertically) usually used in this type of form. In place of tie rods the forms are held together by means of jacks pushed against the trusses of the traveler. These trusses are held at the top by means of cross girders and at the very bottom either by struts placed against offsets in the concrete foundation, or by means of large, heavy removable steel rods spaced 10 ft. apart horizontally. It is stated that this new type of traveling "Blawform" is placed in from one-third to one-half of the time usually consumed in placing a form of this size.

The most notable advantage of this design is that all stresses can be calculated and solved mathematically. Another feature is that the bulkheads, which weigh about 10 tons each, are hinged to the form itself, so that they swing open as a door when the strutting and some bolts are removed, resulting in another large saving of labor and time.

The form works as indicated in the illustration. The first section, furnished with two bulkheads, runs ahead and casts individual blocks. The rear section comes up behind, filling up the alternate gaps between the blocks. This rear section has no bulkheads but overlaps a few inches on the concrete blocks cast in the first section.

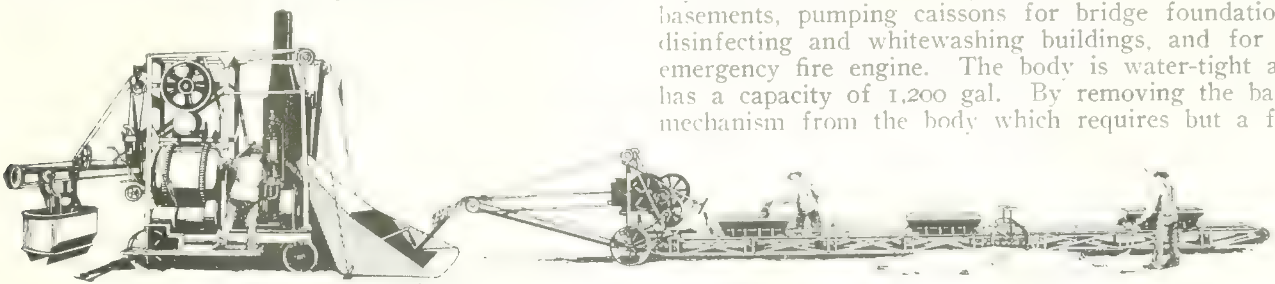


Concrete Wall Construction at Youngstown, O., With New Type of Traveling Form.

It is stated that a section like this can be moved and set in a forenoon and, if the mixer capacity is large enough, can be filled in the afternoon; in hot weather the section can be removed early the next morning and used again in a similar manner. On some jobs it is said a section of this type could actually be used once every day, even if the wall had dimensions as big as 34 ft. in height, 18 ft. at bottom, about 10 ft. at top and 30 ft. long, which is the case in the one shown in the illustration. Generally, however, the work is laid out so that the section is used every other day—that is, with two sections on a job the daily progress consists of a block of the same length as the form sections. The advantages claimed for a form of this type is that a certain schedule can be laid out for the progress of the work and, if the necessary precautions are taken, it can be followed absolutely and the job finished on specified time. The sections are made adjustable, for different cross sections of wall.

PORTABLE MIXER LOADER THAT CUTS OUT LOADING DELAYS AND REDUCES LABOR COST.

A loader that eliminates wheeler work in getting concrete aggregate to the mixer was brought out last year by the Koehring Machine Co., Milwaukee, Wis. The loader is a combination of measuring bins and the belt conveyor principle applied to a light portable machine, which is supplied with its own power and traction. The measuring bins are adjustable, having extendable sides so as to hold the proper proportions of aggregate for any size batch. When the bins are filled by shoveling from the piles a lever control opens the bottom of each bin, permitting the aggregate to fall on the conveyor belt, which carries the material to the mixer and into the loading bin which is then operated in the usual way. The measuring bins are provided with wheels and are moved along the top of the frame to maintain them in convenient shoveling position to the materials. The speed of the conveyor belt, 500 ft. per minute, necessitates the use either of the loading skip or a measuring batch hopper. These serve as a storage supply of aggregate permitting the measuring bins of the mixer loader to be refilled without reference to the discharge of the preceding batch from the drum. The loader is adapted for use either with end loading or side loading mixers. It can be used with any mixer without changes in the mixer except the placing of a baffle plate in open end loading skips. The rated capacity of the loader is 100 cu. ft. per minute with constant feed. Its weight on wheels with 5-H.P. gas engine and steel horse but without bins is 6,195 lb. The overall length of the machine is about 60 ft. and it receives materials from any point within this distance of the mixer. Each bin complete weighs 312 lb.



Koehring Mixer Loader.

A NEW DIGGING AND LOADING MACHINE STATED TO HAVE LARGE CAPACITY AND LOW OPERATING COST.

A new design of digging and loading machine for which large capacity and low operating costs are claimed was brought out last year by George W. Jackson, the well known contractor and engineer of Chicago. The machine is designed for digging and loading ore, shale rock, coal, sand, gravel, earth, etc. It can be used for the shallow excavating required in street grading or for ripping up an old pavement preparatory to laying a new one. It also can be used in mining work and it is claimed that it will dig and load coal from its natural deposit, without blasting, at a rate of 2 tons per minute.

[illegible] be operated by compressed air, steam or electricity, the power consumption ranging from 25 HP. for the smallest size type to 60 HP. for the largest. One man is required for operating.

The Type B machine has a width over all of 5 ft. 4 in., a height of 7 ft. 6 in. and a length of 10 ft. It weighs 8 tons and will make a cut 15 ft. 4 in. wide without moving the caterpillars. The cutting buckets swing in a half circle to do this. This type is furnished with a belt conveyor of any length up to 50 ft. The Type A machine weighs 5 tons and will make a cut 10 ft. wide, and the Type C weighs 10 tons and will handle a cut 22 ft. wide.

HEAVY DUTY AUTO-EDUCTOR FOR CANTONMENT AND MUNICIPAL WORK.

During 1918, the Otterson Auto-Eductor Co., 817 Fairbanks Bldg., Springfield, O., designed and built several special heavy duty auto-eductors for use in U. S. army camps and cantonments for cleaning septic tanks and grit chambers, and for many other uses along these lines. These special heavy duty auto-eductors may also be used for cleaning latrines, cesspools, dry wells, vaults, draining flooded areas, cellars and basements, pumping caissons for bridge foundations, disinfecting and whitewashing buildings, and for an emergency fire engine. The body is water-tight and has a capacity of 1,200 gal. By removing the baffle mechanism from the body which requires but a few minutes' time, the outfit is converted into an ordinary truck for general hauling purposes. The heavy duty auto-eductors are similar to the standard or single stage Otterson auto-eductors which are now being operated in many of the large cities of the United States, with the exception of the eductor casting and pump. The eductor and its connections in the new machine are specially designed to perform the difficult work encountered in cleaning septic tanks and grit chambers. The pump is of the two-stage centrifugal type and is specially designed for use in connection with the Otterson auto-eductor. This heavy duty auto-eductor equipment is mounted on Class "B" Military chassis for Government use in the United States and overseas. The Otterson Auto-Eductor Co. is now mounting this heavy duty equipment on various makes of 5-ton chassis for use in cities where catch-basins vary from 9 ft. to 35 ft. in depth.

The Heavy Duty Otterson Auto-Eductor Mounted on Class "B" Military Chassis.

NEW CUTTING BLOWPIPE.

[illegible] the demands [illegible] tremendous in[illegible] in the [illegible] industries during the war, and especially the need in shipyards for a light [illegible] for work in close [illegible] and below decks, the Oxweld Acetylene Co., Newark, N. J., developed a new cutting blow pipe, known as the Oxweld Model C-6. The weight of this blowpipe is at least 1 lb. lighter than the [illegible] lb. Its over-all [illegible] in. The new model among other features [illegible] type of valve for controlling the cutting oxygen in which an in[illegible] is employed. By [illegible] material, a remarkably tight and durable joint is secured, and the mechanism for operating the valve is materially simplified and strengthened. Oxygen leaks greatly retard pre-heating; hence the importance of this improved valve construction requires no further comment. In addition to the above features, the Model C-6 cutter embodies all the recognized advantages of former Oxweld types, including: Flexibility of movement in any direction without change of position of the operator, which is secured by havng the cutting jet completely surrounded by the pre-heating flame, and maintenance of the correct mixture of gases in the pre-heating flame without recourse to frequent valve adjustment. The blowpipe is furnished with a head angle of either 90° or 75°. The seating arrangement of the internal nozzle insures a thoroughly gas-tight joint. Each blowpipe is equipped with four interchangeable internal nozzles, properly graduated for use on various depths of cut, and by means of which a cutting range of from ⅛ to 12 or 14 in. may be secured.

NEW BUCKEYE CHAIN AND BUCKET TYPE TRENCH EXCAVATOR.

A trench excavator of the chain and bucket type, designed for cutting 24-in., 28-in., 32-in. and 36-in. widths and 12-ft. to 15-ft. depths, has been placed on the market by the Buckeye Traction Ditcher Co., Findlay, O. This new model has practically the same main frame construction and transmission mechanism as the Buckeye "wheel type" excavators. The machine is 10½ ft. wide, 12¼ ft. high and 50 ft. in length. Its traction speed on high is 1 mile per hour. Its approximate shipping weight is 47,000 lb. The main frame is 10-in. steel I-beams. The tractor wheels are Krupp aprons. The buckets are special type pressed steel and can be fitted with either cutters or rooters. The conveyor is a 6-ply belt, 36 in. wide, and is friction driven by large rollers. All controlling levers are banked conveniently at the operator's platform. The power plant is of the heavy duty, medium speed type. A 65-HP. engine is used.

Model C Buckeye Trench Excavator.

DRILL MOUNTING FOR FLAT HOLE WORK.

A new drill mounting specially adapted for such flat hole work as is encountered in driving small tunnels or the occasional large tunnels where shallow holes are needed was brought out by the Ingersoll-Rand Co. The mounting is made to hold either the dry or the wet "Jackhamer." It is but an instant's work to clamp the standard "Jackhamer" in the carriage of the "Jackhamer" mounting. Therefore, a single drill may be used conveniently for the two-fold purpose of drilling flat holes in the heading and down holes on the bench without loss of time in making changes. The clamp which grips the handle of the drill is provided with a cushion spring to take up the shock when a steel is being pulled out of a hole. The forward clamp on the carriage does not grip the machine firmly, but serves only as a support and guide.

Mounting for Either Dry or Wet "Jackhamer."

The carriage is moved by a feed screw which is supported at both ends, these supports acting as tops to prevent the carriage from being fed out of the shell. The feed screw is operated by crank, one turn of which moves the carriage ½ in.

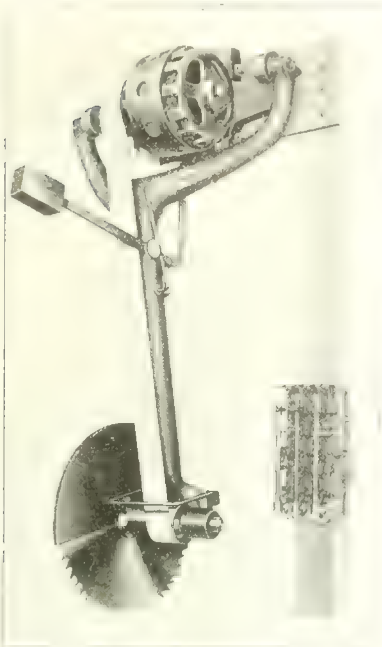
The "Jackhamer" mounting is adapted for use either on the arc of a column or horizontal shaft bar or a tripod, as the standard 5-in. cone upon which the shell rests will fit into any 5-in. Sargeant saddle or clamp. The cone is made to slide on the shell, which gives a quick adjustment when setting up and can be used to increase the length of feed whenever necessary.

The column or shaft bar most commonly used with the "Jackhamer" mounting is a light single screw column type. The "Jackhamer" mounting is built for hard usage, steel casting and drop forgings being employed throughout its construction. The essential details of the mounting are as follows:

Weight	63 lb.
Weight with Jackhamer	104 lb.
Length	39¼ in.
Height	10¼ in.
Distance from center of drilling machine to mounting	2¾ in.
Length of screw feed	24¼ in.
Slide of cone on shell	19¼ in.

SELF-CONTAINED MOTOR-DRIVEN SWING SAW.

A motor-driven swing saw that is being extensively used in shipbuilding and other construction is shown in the accompanying illustration. The installation is very simple and involves very little labor, due to the fact that the machine is complete, having the motor and the necessary driving belt in one unit and all that is required is to clamp it against any convenient wall, or column, or supporting brackets from the ceiling, or supports from the floor at the rear of the table. The type shown is equipped with either 32-in. blades and 7½-HP. motor for timbers up to 10 in. square, or 36-in. blade and 10-HP. motor, capable of cutting timbers up to 14 in. square. The manufacturers, the Reno-Kaetker Electric Co., 41 Main St., Cincinnati, O., also build a line of smaller sized machines.

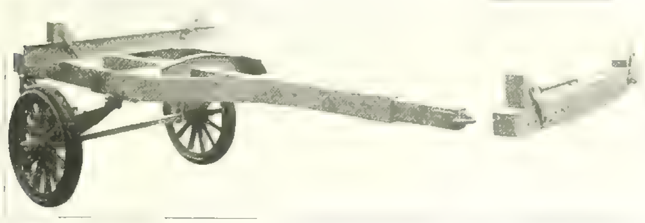


Motor Driven Swing Saw.

SEMI-TRAILER FOR HAULING HEAVY PIPE.

A semi-trailer, of particular usefulness in handling heavy pipe is shown in the accompanying illustration. This trailer is adjustable in length from 12 to 20 ft., and is of 4-ton capacity. It is operated with either a 1 or 1½-ton truck.

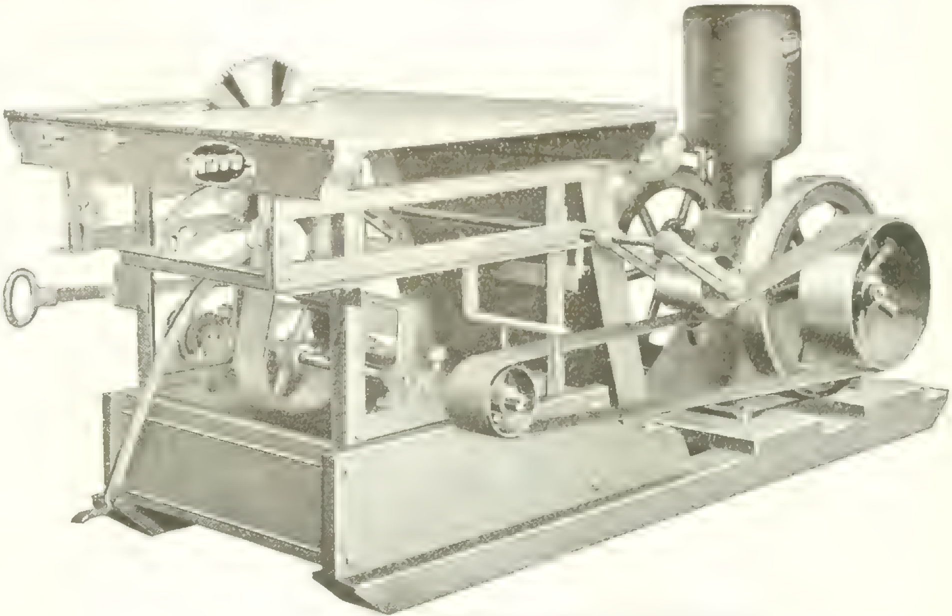
The trailer is equipped with removable wedge blocks on the front and rear bolster. The front bolster goes with the trailer as well as a steel circle fitted on the truck upon which the bolster turns. This front bolster is attached to the platform of the truck over the rear axle by means of a steel king pin. The trailer pulls from a trailer connection on the rear of the truck frame. This semi-trailer was designed by Mr. August C. Fruehauf, president of the Fruehauf Trailer Co. of Detroit, Mich.



Semi-Trailer for Hauling Heavy Pipe.

CONTRACTORS' SAW RIG.

A saw rig, designed to meet the needs of the contractor, builder and cement worker, who uses large quantities of lumber for cement forms, frame work of buildings, etc., was placed on the market last year by the Novo Engine Co., Lansing, Mich. The frame of the outfit is made of 2-in. steel angles securely riveted together. Heavy wood skids 7½ ft. long on which the saw fram and engine are mounted make the outfit extremely rigid. The over all length of the outfit is 8 ft. The table top 42 in. by 47 in. in size is only 37 in. above the ground level. The table is adjustable for any depth of sawing and swings back or locks up in a convenient position to permit change of tools. One of the greatest advantages of this outfit is the swing cut off feature. A cross cutting gauge is furnished with the outfit. The cross cut gauge is adjustable for different widths of cutting and has an adjustable stop for the lengths required. In the handling of heavy material it is much easier to move the saw than to move the material. This feature cannot be emphasized too strongly as it is not only a much faster and safer method but a much easier method especially with large and long timbers. It also permits the use of saws of sufficient size for large timbers.



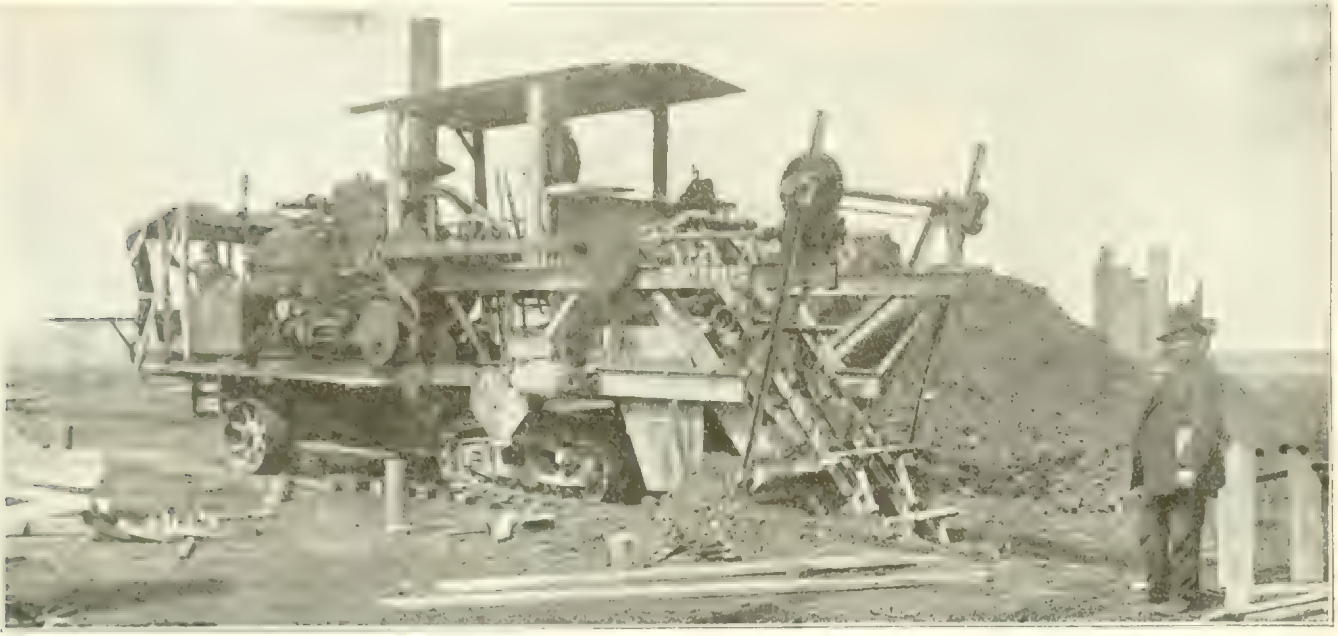
Rip and Swing Cutoff Saw Rig.

A SHEET STEEL PRESSURE PIPE WITH SPIRALLY WOUND SEAMS.

A pressure pipe made of 12-gage or lighter sheet steel with a lock seam wound spirally around the body of the pipe has been placed in production by the Naylor-Robertson Co., 1036 W. 37th St., Chicago. The pipe is of narrow, continuous strips of sheet metal wound spirally into an elongated cylinder. The adjoining edges of the strips are contorted as the strips are being wound around a mandel, to jointly form an overlapping continuous pressure tight locking seam. The seam intermediate the convulations is compressed as it is being formed, so as to produce such a tortuous path from the pipe interior through the interfolded parts to the exterior of the pipe, as to render it as impervious to penetration as the body part of the strip. This pipe is made by a new machine invented by Mr. Carl Naylor of Chicago. It is claimed that the method of operation employed by this machine makes possible the elimination of crystallization or over-stretching of the metal at point of the seam. The pipe is made in continuous lengths and the machine is provided to handle any width of [illegible] strip, thus making the degree of pitch of the spiral seam correspond to the pressure required.

NEW BUCYRUS TRENCH EXCAVATOR.

A new trench excavator, in which complicated mechanism has been eliminated and the number of wearing parts reduced to the lowest possible minimum, was placed on the market by the Bucyrus Co., South Milwaukee, Wis. The gears, bearings, shafts, engines, boiler, etc., are of steam shovel design and the machine is stated to be built with the simplicity, strength and ruggedness of a steam shovel.



The Class 72 Trench Excavator Brought Out Last Year by the Bucyrus Co.

In this trench excavator sprockets, chains and belts have been entirely eliminated in the main drive. The engine pinion drives a large gear on the jack shaft which drives the upper tumbler shaft by means of two heavy side connecting rods pinned to steel crank discs at each end of the shafts. The discs are accurately quartered and one disc on each shaft is split and clamps on so that they can be easily removed and any part on the shaft readily dismantled.

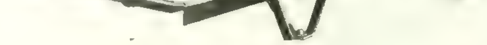
The steel buckets are of the open or scraper type attached to the chain links by means of steel arms and can be easily taken off when changing from one size to another. The links are annealed steel castings, of simple design. They are 14-in. pitch, are connected by means of heavy case hardened forged pins and are provided with renewable case hardened bushings.

The standard ladder is designed to dig 17 ft. or less below wheel base, and the same ladder is used for all sizes of buckets from 24 in. to 72 in. The ladder is provided with a removable section which may be taken out when digging 12 ft. or less, and when so ordered an extension to dig to a depth of 20 ft. can be supplied.

The conveyor is driven by an independent reversible engine so that its operation and speed are entirely independent of the operation and speed of the machine. It is controlled by levers at the operator's stand and runs in either direction at any speed up to 650 ft. per minute. The operator's stand is located on top of the frame just ahead of the digging ladder, where he has a full view of the machinery and can also see to the bottom of the trench as well as the road ahead. The variation of digging speed is controlled by a lever at operator's stand and is changed without stopping the machine. The machine is mounted on Bucyrus caterpillar traction at the rear and traction wheels at the front.

5 FT. MIXER MOUNTED ON 2-WHEEL TRUCK.

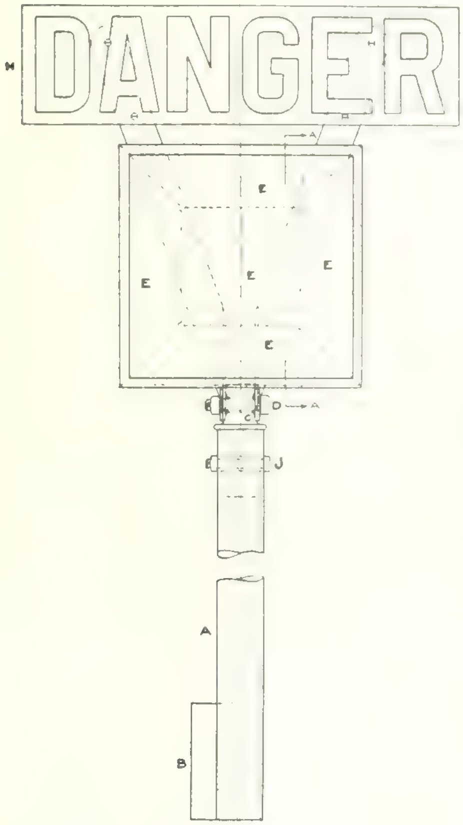
A 5 ft. mixer with rear discharge on 2-wheel trucks has been added to the line of the Ideal Concrete Machinery Co. of Cincinnati, O. This mixer is equipped with standard gage trucks and large wheels, also having strong axles to enable it to be pulled around the country behind a team or motor truck. The platform which is an integral part of the mixer is large enough for a wheel barrow to be turned around on, and is only 16 in. above the ground, making the loading from wheel barrows a very simple proposition. The mixer is especially useful in sidewalk work as it can be placed straddle the forms and moved along the job, the concrete being deposited directly between the forms from the mixer. In the case of foundations or similar work the mixer can be backed up to the forms and the concrete deposited directly in place without wheel-barows. The machine is equipped with a high-grade vertical 3-HP. engine. The trunnions are chilled and have self-oiling bearings. The drum sheet and blades are steel, 1/8 in. thick. The mixer is built in every way to stand the hard knocks of general contracting service.



New Ideal 5 ft. Mixer.

NEW AUTOMATIC HIGHWAY SIGNAL THAT SHOWS RED DAY OR NIGHT.

A highway signal that operates on the principle of angular reflection and shows a red danger warning both day and night is illustrated below. This effect is obtained by means of five mirrors (designated as E.E. in the cut) arranged to reflect light through a special transparent, sensitive pot-colored crystal glass lens. The signals have neither wick nor wire, nor moving parts or light of any sort. In the daytime the signal appears as a brilliant red square. At night it penetrates the darkness with a powerful reflected red light. The signal is made by the Automatic Signal & Sign Co., Canton, O.



FRONT

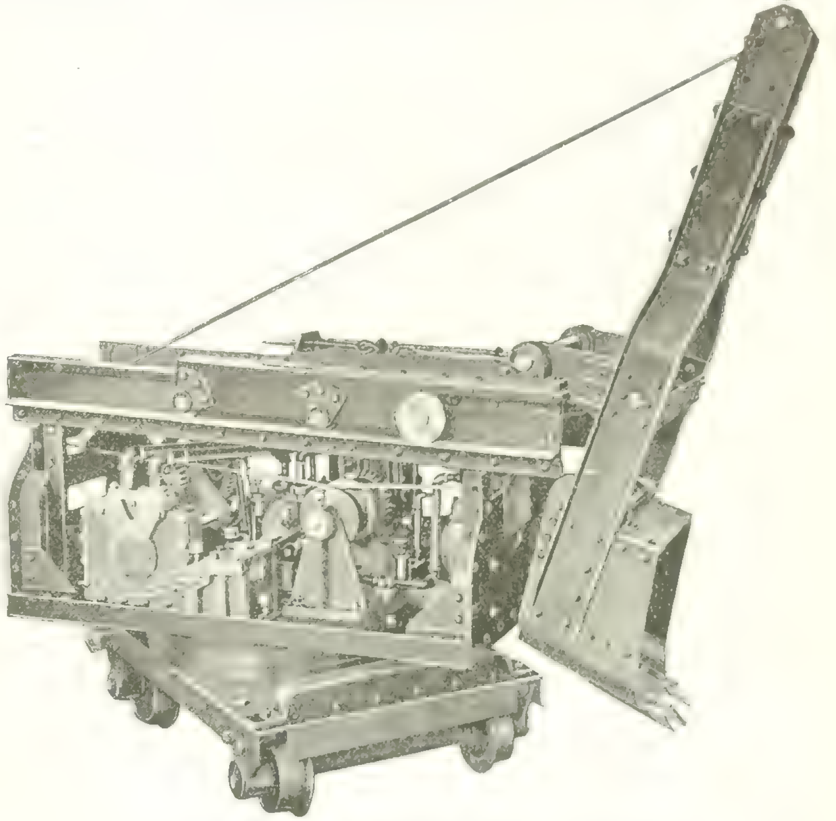
Automatic Danger Signal That Lights Itself.

MECHANICAL LOADER FOR HANDLING DIRT AND ORE IN NARROW DRIFTS.

A mechanical loader particularly designed as a mining shovel for loading dirt and ore in narrow drifts was placed on the market during the early part of 1918. The loader is the invention of Capt. Samuel Hoar of Virginia, Minn.

The cut shows the loader with the sides of the frame removed and gives a view of the power mechanism. The power unit consists of three Dake air operated reversible engines with gearing and drums all compactly installed on a bed 30 in. x 53 in. Five horsepower engines are used for hoisting and thrusting, and a 3-HP. engine for swinging. The three movements are therefore independently controlled and the shovel may be run forward on the thrusting table at the same time it is being hoisted, enabling the operator to take the load from any location in the pile, and also clean up the dirt as completely as by hand labor. The thrusting table to which the dipper is attached can be run back and forth, enabling the operator to clean up more space before moving the shovel, for which purpose the shovel is also self-propelling.

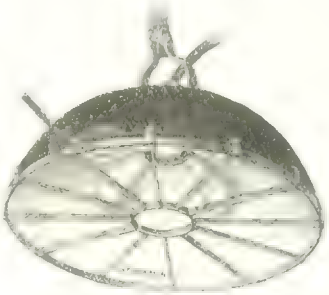
The frame describes a complete circle on the truck, thus giving it a wide range of operation and will load into cars directly behind the shovel. The three Dake engines are arranged with remote control and are operated by levers from the operator's seat which it attached to the left side of the frame. The loader weighs about 4,000 lb.; height when working, 5 ft. 6 in.; width, 3 ft. 6 in.; length, 6 ft.; revolves in 7-ft. wide drift, and operates with air pressure of 80 lb. The track gage is adjustable from 18 in. up. It is claimed the shovel will load in two hours more dirt than two men can load in 8 hours.



Mining Shovel That Is Claimed to Do as Much Work in 2 Hours as 2 Men Can Do in 8 Hours.

LIGHTING HOOD FOR GENERAL CONSTRUCTION WORK.

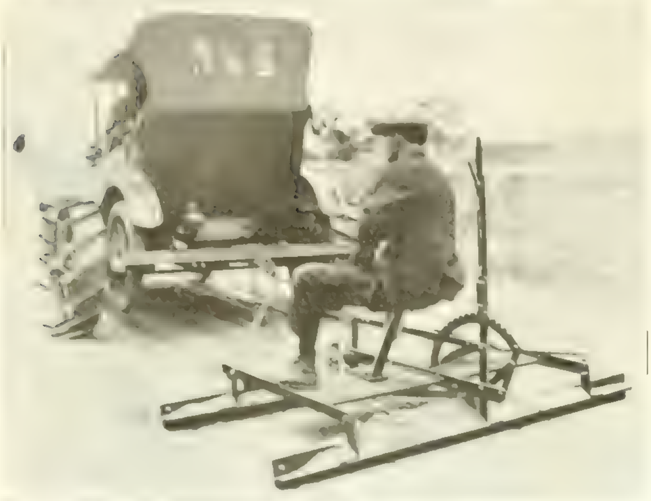
A lighting fixture designed for heavy out-of-door service, particularly around wharves, dry docks, in steamship holds, in building and general construction work, has been placed on the market by the Benjamin Electric Mfg. Co., 120 South Sangamon St., Chicago. The fixture consists of a 16-in. hood, non-discoloring white paint enameled inside, black on outside with cluster body, and a strong galvanized iron guard. It is furnished with a fitting for suspension by rope. This permits shifting the fixture from one location to another quickly, so that the light can be directed most effectively on the work. The reflector bowl can be adjusted to throw the light at various angles—directly below or sidewise by tipping bowl with rope attached to loop on the guard.



Benjamin Cargo Light.

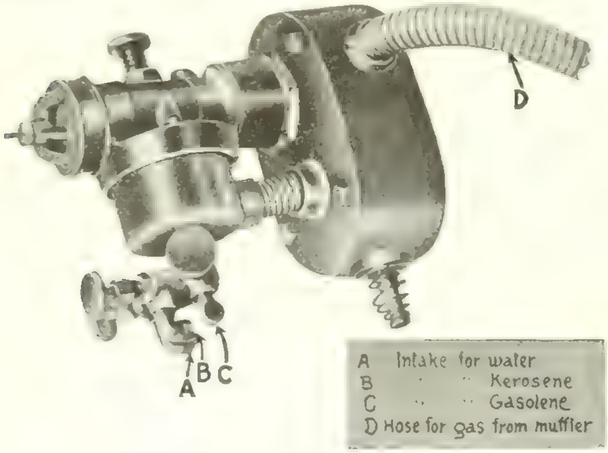
ATTACHMENT THAT MAKES A FORD CAR A TRACTOR.

An attachment that transforms a Ford car into a tractor capable, according to the claims of the manufacturer, of doing the work of 4 horses, has been placed on the market by the Globe Machinery & Supply Co., Des Moines, Ia. In the attachment the frame of the tractor unit is bolted to the rear axle of the car and clamped to the front axle, thus establishing a three-point suspension. This frame can be left on the car throughout the season. The tractor wheels are carried on an axle located ahead of the Ford axle. Attached to the tractor wheel axle is a raising and lowering device by which the traction wheels can be raised permitting the car to run on its own wheels at the regular rate of speed. When the tractor wheels are down the reduction of speed is 1 to 10. The attachment has a positive cooling device for preventing overheating of the engine.


Road Dragging With Globe Tractor Attachment.

CONCRETE MIXER USES EITHER GASOLINE OR KEROSENE AS FUEL.

A carburetor that is claimed to effect a 33 per cent to 50 per cent reduction in fuel costs was used last year on the engines of the concrete mixers of the Northwestern Steel & Iron Works, Eau Claire, Wis. This twin service carburetor permits the operator to use either gasoline or kerosene in the engine, as desired. The illustration shows two lead pipes from the storage tank, each with a shut-off valve, enabling the operator to draw either fuel as wished. By means of a superheating attachment, which introduces gas from the muffler of the engine, the kerosene is volatilized to the proper point for producing the maximum explosive power within the cylinder. The engine is equipped with gravity feed from the fuel tank.

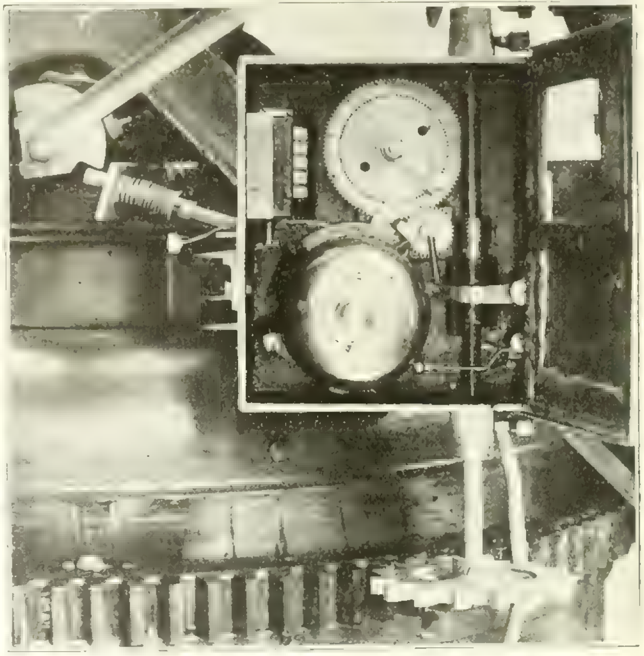


"Northwestern" Twin Service Carburetor.

AUTOMATIC DEVICE FOR REGULATING MIXING OF CONCRETE.

Among contractors there is a familiar remark that it takes yardage to make profits. How to get this maximum yardage is always a problem; and chiefly so, because there is the temptation to do it at the sacrifice of quality. This latter condition quite naturally involves the highway engineer. While both the contractor and engineer may have the best intentions, they are nevertheless working in opposite directions, and sometimes the result is disorganization and friction, where harmony should exist. Any device which will assist in eliminating such conditions is not only desirable, but actually necessary. Such a device, used in constructing 14,000 sq. yd. of concrete pavement at Buffington, Ind., is shown in the illustration.

By analyzing our present methods, we find the operator of the mixer is usually depended upon to properly mix the materials. In addition to this, he has the following duties: observe the operations of his engine in a general way, raise and lower the skip without striking careless workmen, supply the proper amount of water for the mixture, and, finally, operate the bucket in placing the concrete. Then, in addition to all these operations, we expect this man to be efficient in guessing to a few seconds the time concrete is in the dump. The batchmeter not only relieves the operator of this burden, but the engineer or inspector knows by the sound of the bell that the materials have been sufficiently mixed.


The Batchmeter.

One of the most unusual features of this device is the effect produced by the ringing of the bell. It seems to affect the whole organization in that the men in front of the mixer speed up to receive the coming batch; also the men behind the mixer are awakened to the fact that their material should be in the skip in the next few seconds, to prevent delay.

COMBINATION AUTO STREET SPRINKLER AND FLUSHER.

The accompanying illustration shows a combination machine developed by the F. C. Austin Co., Inc., Chicago. An important feature of this flusher and sprinkler is the pump. This is so constructed that wear caused by sand, silt or grit in water is taken up automatically through centrifugal action of the impellers. Another feature is the method of controlling the flow of water to the nozzles. This is done by one valve, thus doing away with a multiplicity of levers for operating the nozzles. The tank is made of a heavy gage black steel and is mounted on oak saddles, reinforced with metal sides. The pump has a capacity of 400 gal. per minute, and any pressure up to 60 lb. can be maintained. The four flusher nozzles are of the combination type, and are instantly changeable for flushing or sprinkling. They are located at the front and center of the machine and can be adjusted to flush either side of the street.

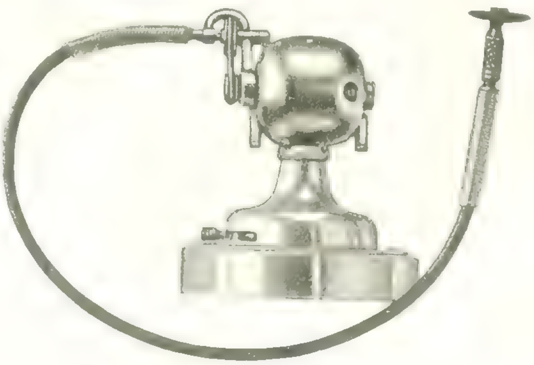
Combination Auto Flusher and Sprinkler.

"MUSHROOM TOP" EXPANSION JOINT FOR PAVEMENTS.

A new pre-formed filler for pavement joints has been placed in production by the Standard Asphalt & Refining Co., Chicago. The joint proper consists of a core of tough, tenacious asphalt reinforced with two bands of flexible felt. The novelty of the design consists in the termination of the felt reinforcing a short distance below the top of the joint, leaving a narrow section of the asphalt core entirely exposed. The advantages claimed for this construction are as follows: First—Actual contact is obtained between the pliable "Mushroomed" asphalt core and the sidewalls of the joint. Second—The "Mushroom" is expanded in the joint space by the weight and impact of traffic forming a permanently watertight contact between the pliable "Mushroom" core and the joint walls. Third—As installed about ¼ in. of the "Mushroom" should project above the joint. This projection is gradually reduced by being wedged tightly into the joint by traffic. The surplus is gradually spread over the edges, forming a tough, permanent armor, which protects the corners against damage by traffic.

ERASING MACHINES FOR DRAFTING ROOM.

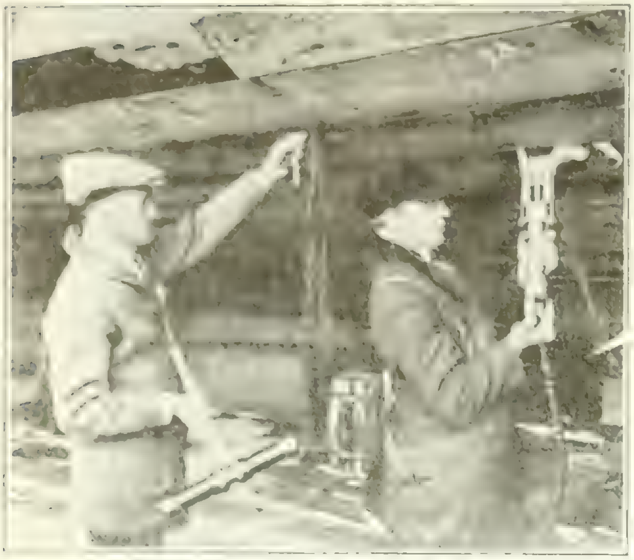
A motor-driven machine for cleaning drawings is one of the latest conveniences for the drafting room. The machine is driven by a variable speed motor which can be attached to any electric light socket and will operate on either direct or alternating current. The flexible shaft connecting the circular eraser and motor is 3 ft. long, and is attached to a counter shaft driven by a belt. The machine is made by Koelsch & Co., 138 Fulton St., New York.



Circular Eraser Driven by Motor.

PNEUMATIC MACHINE FOR MECHANICALLY CALKING WOODEN SHIPS.

Wooden ships must be rendered seaworthy by calking the seams of decks and hulls with oakum. This important operation has formerly been performed entirely by hand. Every type of wooden vessel which is constructed with [illegible] sheathings and wooden decks as well, [illegible] concrete ships requires calking. Hand calking calls for a large amount of skill to perform the initial operation that of "tacking" the oakum into place



Old and New Methods of Ship Calking.

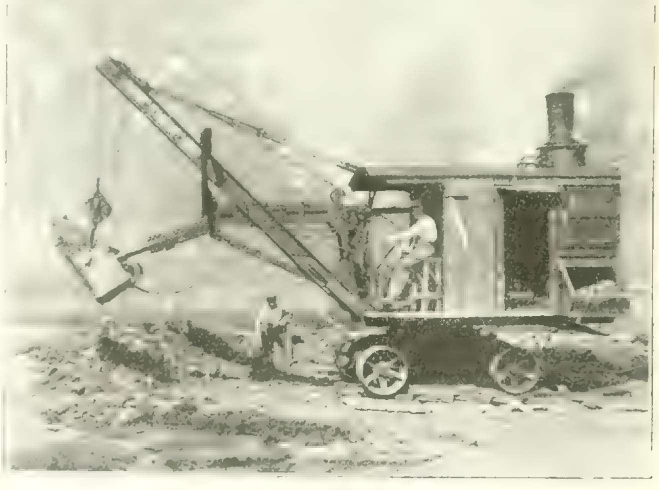
after which it is driven into the seam as far as necessary, an operation called "horsing." This usually requires two men, one holding the "horsing" iron in place and the other wielding a heavy mallet. Needless to say, hand calking is rather a slow and laborious operation, and considering the skill and knowledge necessary to the performance of "tacking," an expensive one. A pneumatic machine for mechanical calking has been brought out by the Ingersoll-Rand Co. This machine—the "Little David" No. 23 calking machine—is shown on the right in the illustration. The machine is neither ponderous nor intricate, weighing but 13½ lb. with an over-all length of 22 in., and having but seven major parts, all of which are so constructed as to give the greatest possible amount of service with the smallest possible wear. The "Little David" calking machine is controlled by a trigger similar to that of a light pneumatic scaling hammer. It differs, however, from the usual hammer in that the piston has an extended rod fitted with a thin calking blade. This, being a reciprocating iron with a positive pullback, has no tendency to bind. The calking iron travels in guides which prevent it from turning, the whole being fitted with springs so that the workman can vary the penetration of iron with the varying depth of the seam. A unique device automatically feeds the oakum with each movement of the calking blade. Guide wheels run in the seam being calked and keep the calking iron lined up. The tool operates with negligible vibration, and it follows without effort on the part of the workman; in fact, machine calking is made so simple that ordinary workmen can do highly efficient work. The ordinary equipment consists of a calking iron 1/16 in. thick, although an ⅛-in. iron can be furnished if required. In a test recently conducted 35 ft. of deck seaming were completed in 3½ minutes or almost 10 times as much as can be accomplished by hand work the same length of time. An important feature of the machine is that which gives the regular twist or turn to the oakum, as it is driven by iron. This feature is one of the points which heretofore had been only possible with hand calking and which was deemed impossible to machine design until the advent of the "Little David" calking machine. Special care is taken by the manufacturer of this machine to heat treat all parts necessitating hardening, in order that machines when placed on the market will be as nearly proof against wear as is mechanically possible. A little feature which will demonstrate the thoughtfulness of the manufacturer will be observed in the fact that the hand hole in the handle of the machine is sufficiently large to permit the worker to wear heavy gloves during the cold weather and still maintain his grip.

NEW SHOVEL HAS WIDE RANGE OF SERVICE.

Foreseeing that contractors' and industrial plant equipment for the post-war construction period must have a wide range of usefulness, The Thew Automatic Shovel Co., Lorain, Ohio, in 1918 added to its list of products the Type 00 Series. The Type 00 is a light weight, readily portable machine. It is so designed that, with very minor changes, it may be equipped for steam, electric or gasoline operation. Change from one form of power to another can readily be made in the field, and at reasonable expense. Independent double reversing engines are employed for hoisting, crowding and swinging when the power is steam. For electric and gasoline service, a single motor is used, operating at constant speeds. The various motions are controlled through reversing frictions.

When equipped as a shovel, the machine is regularly mounted upon a truck with wide-tired traction wheels, with both hand and power steer. It is self-propelling at speeds approximating 1½ miles per hour. The Type 00 weighs only 14 tons and regularly uses a ½-yd. dipper.

By adding an auxiliary shaft carrying two drums, and the substitution of a longer and lighter boom, the shovel is converted into a crane capable of handling a ½-yd. clam shell bucket, with a working radius of 25 ft. When equipped for electric or gasoline motor, this auxiliary shaft controls the dipper crowding motion. The only change, then, from shovel to crane lies in the exchange of booms. All drums are power driven and the machine is quickly adapted to clam shell or drag scraper service.

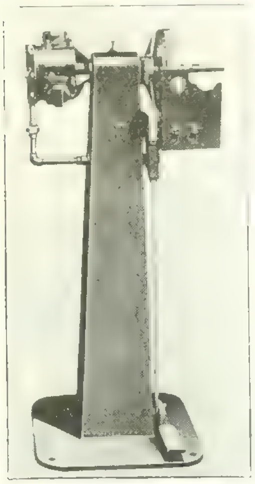


New Light Weight Shovel.

The Type 00 has been mounted upon special trucks for foreign military service. The military traction truck was designed to secure a 5-ton crane which could be hauled behind a motor truck and over ordinary macadam roads at speeds up to 10 miles per hour. The truck is spring mounted, with swivel joint steering wheels and suitable brakes. It is also self-propelling. For use on narrow gage industrial railways, the Type 00 crane superstructure is mounted upon double trucks, distributing the weight over eight wheels. Inasmuch as the usual gage of such railways is 60 centimeters, or approximately 24 in., it is evident that the use of jacks or outriggers is necessary when operating as a crane. With jacks set, loads of 10,000 lb. may be handled, thus meeting the usual rating for a 5-ton crane.

A NEW GRINDER FOR THE DRILL SHARPENING SHOP.

Imperfectly made drill shanks; that is, not properly square on the end, throw a strain on the hammer drill piston and are the chief cause of piston breakage. This is an expensive item not only in the cost of part replacement, but also in the time that the drilling machine is out of commission. Further, with imperfect shanks it is not possible to take advantage of the full force of the piston blow and drilling speed is retarded.



Little David Grinder.

As a blacksmith shop help in securing shank perfection, the Ingersoll-Rand Co. has developed the "Little David" pedestal grinder. This, like the sharpener and punching machine, operates on compressed air. It is light in weight, readily portable and requires only a planking support. The 3-cylinder motor operates in a bath of oil. Power consumption is said to be very low.

A single foot lever controls the machine, leaving the blacksmith free to hold the steel with both hands. Ordinarily the grinding wheel used is 8 in. diameter and 1-in. face. As a further convenience the spindle is fitted with a No. 2 Morse taper socket to take a rose reamer for counter sinking the hole in the end of the shank. This operation guards against cutting the water tube of the drilling machine.

The Little David Grinder also finds employment in truing the edges of drill pits, pointing picks and grinding other tools around the blacksmith shop.

The complete machine weighs 105 lb., is 44⅝ in. high and occupies a floor space 17x20⅜ in. It operates satisfactorily with air pressures of 60 to 100 lb. per square inch.

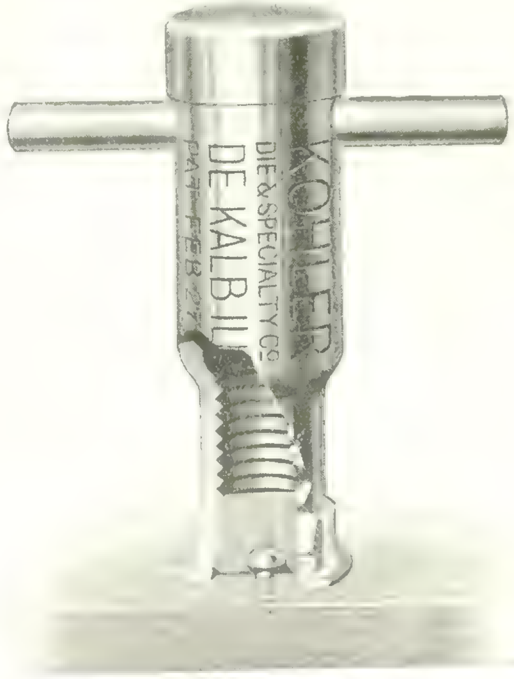
DEMOUNTABLE TRUCK BODY FOR HANDLING BRICK.

A truck body, specially designed for conveying brick, has been placed in production by Greer & Fontaine, Roanoke, Va. The bodies are demountable—one being loaded at the kiln or brick yard while the other is in transit. By this arrangement it is possible to keep the motor truck running nearly all the time. About 3 minutes is required for exchanging an empty for the loaded body, and about the same time is required at the place of delivery for unloading. A [illegible] unloading the bodies, thus permitting the contractor to conserve his space in stacking his materials.

Two Ton Truck Body With Capacity for 1 M Standard Building Brick.

PRESSED STEEL CONCRETE INSERT.

A pressed steel insert adapted for use with either steel or wood forms is illustrated. The insert is set in the form by means of the screw point shown in the cut. A blow with the hammer and a turn by hand sets the screw down so that the insert is held securely in a vertical position ready for the concrete to be poured. After the work is finished the forms are easily pulled away from the screw points which are then quickly removed with the fingers leaving the tapered hole free for the threaded bolt. The insert is made in various sizes ranging from ⅜ in. to ⅞ in., by the Koehler Die & Specialty Co., De Kalb, Ill.



Koehler Steel Concrete Insert

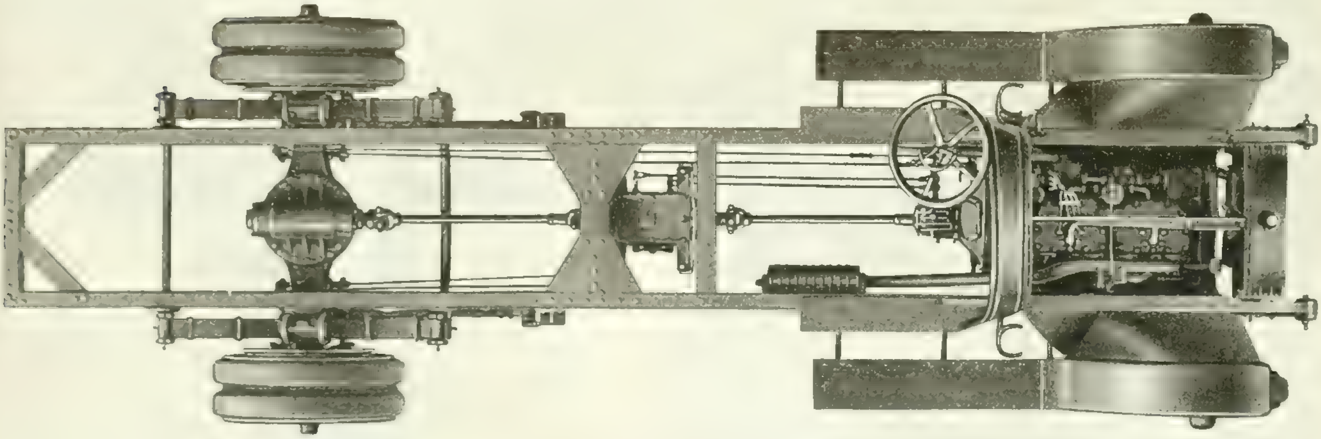
PNEUMATIC PUNCH FOR HOLLOW DRILL STEEL.

The accompanying illustration shows a device adapted for attachment to the Sullivan drill sharpening machine to permit rapid and convenient punching out of the hole in hollow drill bits and drill steels. A Sullivan "DB-13" air hammer drill, such as is used frequently for bench cutting and trimming, is the tool employed in the device. This tool weighs 13 lb. Its two essential features are a push throttle handle and a nose chuck with a knurled or milled cap, which is screwed to the end of the cylinder to hold the drilling tool in position. The tool is supplied with a collar forged on the shank to prevent it from being pulled out of the chuck. The drill is placed at the back of the sharpener on a special clamp or brace bolted to the frame for this purpose, and so arranged that the handle of the tool is permanently held while the cylinder is left free to slide back and forth on a support. The method of using the tool is as follows: The bit is forged and sharpened first in the usual manner. The operator then places the bit end of the steel over the end of the punch, which is inserted in the chuck of the "DB-13" tool. A slight thrust by the operator opens the throttle and starts the tool reciprocating so that the hole is quickly opened to full size. When the punch has advanced far enough into the steel, a quick pull releases it. Some punches have been made up with a blunt end, with the diameter of the punch reduced just back of the point. This is said to give better results in removing the steel from the punch. In some cases operators have elaborated the bracket for holding the "DB-13" tool by adding a guide arm in front on which the steel can be rested when thrusting it onto the punch. This is said to save time in handling. This special attachment will be regularly furnished on any Sullivan drill sharpening machine, and when so furnished the tool is equipped with a special handle and is permanently placed in an opening cut in the vertical frame for it.

Steel Punch on Drill Sharpener

NEW 5-TON ACME TRUCK.

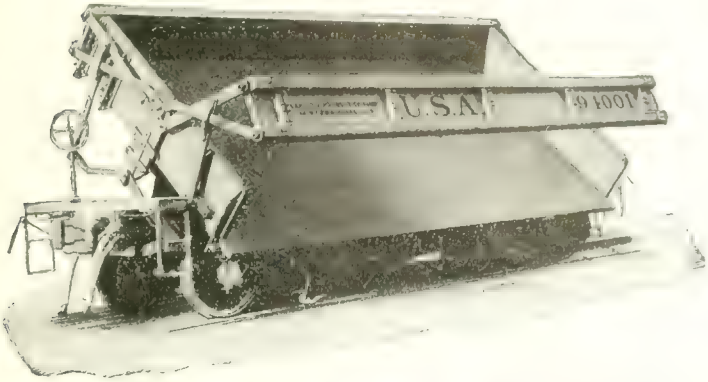
A new Acme truck designed for contracting work, heavy freight hauling and dump truck service, has been announced by the Acme Motor Truck Co., Cadillac, Mich. The truck is of 5-ton capacity. It will be equipped with the latest 55-HP. Continental Red Seal production, known as "B-2" motor. Throughout the new 5-ton Acme, oversize design predominates. The frame, for instance, is 9 in. deep, made of crushed steel and heat treated. The transmission gears have 1½-in. face, and so, throughout, this truck is designed to meet the severest service. Like all other Acme models, it has the cotta transmission. The carbureter is a Ralfield, the governor is of special design and limits the speed to 12½ miles per hour. The wheel base is 180 in.; the chassis length is 261 in. over all, and the loading space is 160 in.



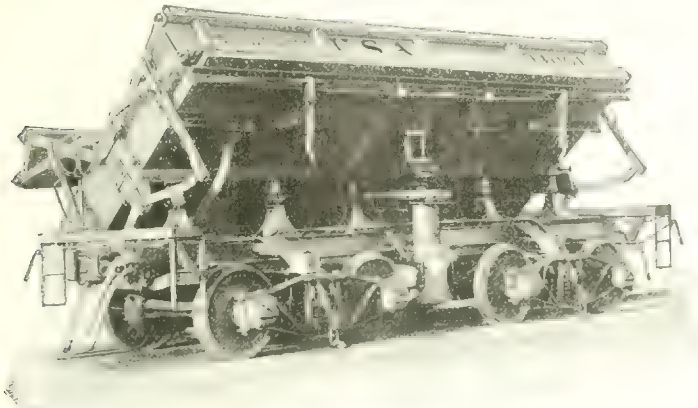
Plan View of the Acme 5-Ton Truck.

DUMP CAR WITH SIMPLIFIED AIR DUMPING DEVICE.

A vertical cylinder dump car with simplified air dumping device, which gives quicker action with less air pressure was brought out last year by the Western Wheeled Scraper Co., Aurora, Ill. In this device the cylinder push rod engages directly with the body of the car, eliminating all loss of power due to cables, sheaves, etc.


12-Yard Air Dump Car With Vertical Cylinder and Side Chains

The thrust of the piston is applied near the outer edge of the car bottom, so as to give as great a leverage as possible, thus further reducing the amount of power needed. The car is supplied with safety chains to hold the bed in upright position when being loaded or transported. The car is of the approved Western type, with built-up doors pivoted to give large discharge opening, steel dumping angle and separate hinge construction. It is claimed this car will stand up under hard usage at a minimum of expense, and with great rapidity of operation. It is made in four sizes: 12 yd., 16 yd., 20-yd. and 30-yd. capacity, the last named having two cylinders on each side.

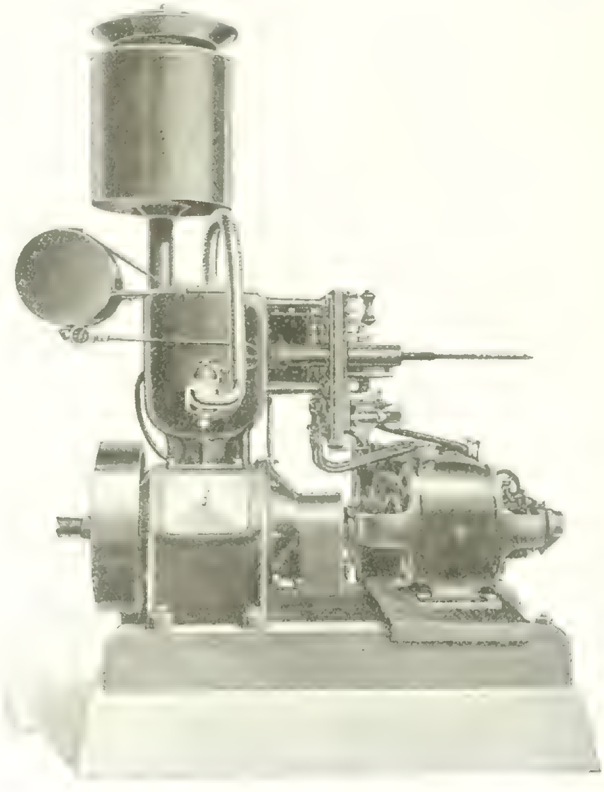

In Dumping Position.

HAIR MAT FOR REMEDYING FAULTY ACOUSTICS IN OFFICE BUILDINGS.

Present day fireproof construction often tends toward faulty acoustics; the hard, flinty surfaces that form the walls and ceilings catch the sound waves and throw them back multiplied and magnified. A method of eliminating this trouble has been developed recently. This consists of the application of a scientifically constructed mat of woven hair to the ceiling and when necessary to other points. The millions of minute interstices of the mat absorb the sound waves in both direct and reflected action. The mat is covered in such a way to give the appearance of a pleasing and harmonious finished surface, without injuring the power of absorption. It in no way detracts from the architectural appearance or the decorative scheme. This method is known as the Wilson Echoliminator Treatment. The treatment is either installed by engineers of the Department of Insulation and Acoustics of Wilson & Co., Chicago, the points of faulty acoustics being discovered and treated to eliminate the echo, or the work can be done by the construction department of any firm.

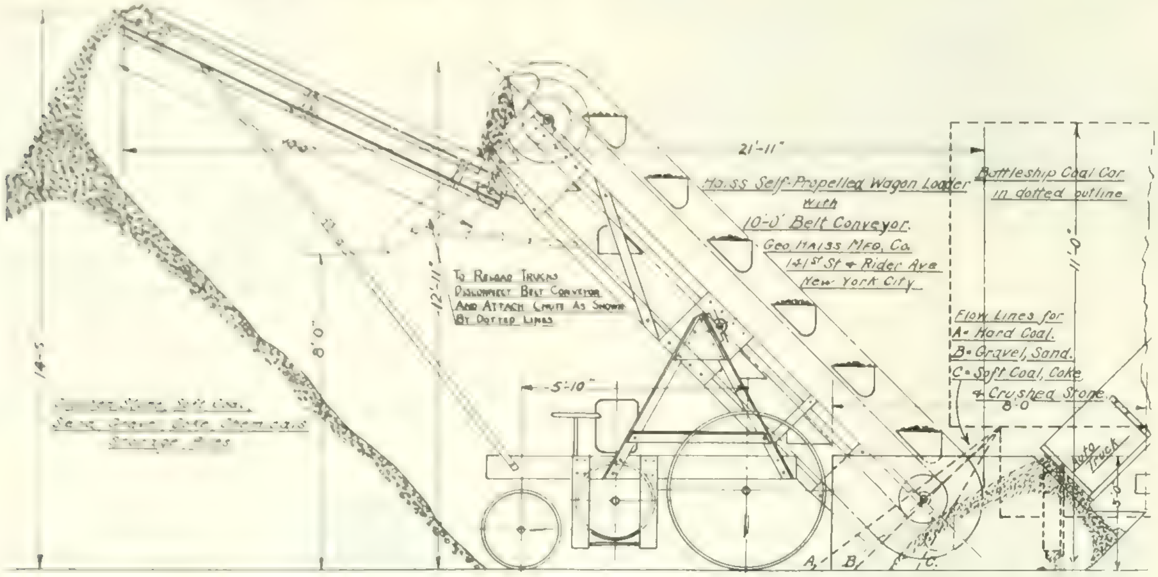
110-VOLT NON-BATTERY POWER AND LIGHTING PLANT.

A small automatic electric power plant should find a field of usefulness on construction work. A plant of this kind could be used for lighting camp buildings as well as such outdoor work as required illumination at night. Such an outfit, designed primarily for farms, is illustrated below. The engine is a single cylinder, 4-cycle, valve-in-head type. The generator is duplex wound, having 110 volts on the power and lighting end and 7½ volts on the other end which is used as a motor (from the 6-volt starting battery) in starting the plant. The switchboard is simple in construction and positive of action. It consists of a relay and two electro-magnets, also an automatic cutout of simple design to protect the battery in case gasoline tank is empty. The operation of the plant is as follows: When any light (or power) is turned on anywhere on the farm, it closes the circuit of the relay and this in turn closes the switch on the starting motor which starts the engine. When 90 volts are reached, the 6-volt current cuts out and the 110-volt cuts in. This operation reverses when the last light or power is turned off and plant then stops. The voltage regulation is accomplished by an electric solenoid governor which acts directly on the throttle of the carburetor. The plant is sold by the Automatic Light Co., Inc., McKnight Bldg., Minneapolis, Minn.


The Alco 110 Volt Power and Lighting Plant.

ELEVATING AND CONVEYING MACHINE FOR HANDLING LOOSE MATERIALS.

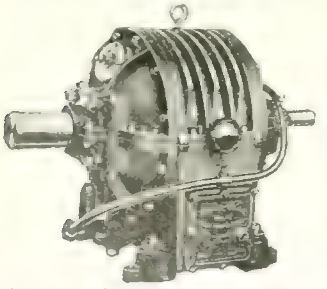
The demand by industrial plants and coal dealers for machinery to simply and quickly unload railroad cars containing run-of-mine coal, and the still more urgent appeals made by the United States Government engineers for mechanical help to speed the loading and unloading of sand, gravel and crushed stone on war construction jobs, brought about the designing and manufacturing of the machines illustrated by the accompanying drawing. This elevating and conveying machine is portable. The operator stands on a platform fastened to the chassis, from which position he has full control of the elevator buckets, the belt conveyor, and the propelling mechanism which moves the entire machine backward or forward, and at the same time he can steer the loader by means of a hand wheel which operates through a worm and sector and steering knuckles to the wheels on the auto truck axle. The machine is operated by an 8 or 10 H. P. gasoline engine, or electric motors may be installed. Large clutches engage the elevator and propelling mechanisms on the gas engine equipped machines, while the latest type of roller-circuit-breaker-switch starts the loader on the electric motor equipped type. A capacity of 60 tons per hour is claimed. The machine is manufactured by the Geo. Haiss Mfg. Co., 141st St. and Rider Ave., New York City.


21'-11"
Haiss Self-Propelled Wagon Loader with 10'-0" Belt Conveyor.
Geo. Haiss Mfg. Co.
141st St. & Rider Ave
New York City
Battleship Coal Car in dotted outline
To Reload Trucks Disconnect Belt Conveyor And Attach Chute As Shown By Dotted Lines
12'-11"
14'-5"
8'-0"
5'-10"
11'-0"
Flow Lines for
A- Hard Coal.
B- Gravel, Sand.
C- Soft Coal, Coke & Crushed Stone.
8'-0"
Auto Truck
A
B
C

Self Propelled Wagon Loader with 10-ft. Belt Conveyor.

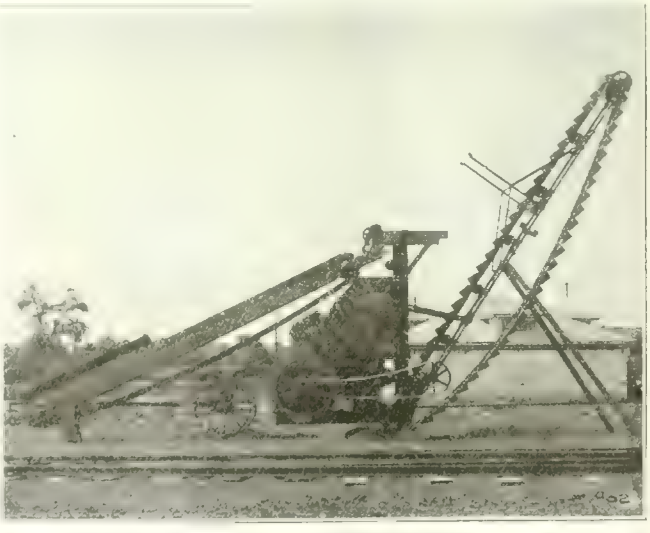
SPEED TRANSFORMING EQUIPMENT FOR CENTRIFUGAL PUMP.

A speed transformer for pump drive that occupies small floor space and requires a minimum of attention and adjustment is illustrated. This reduction gear is known as the Turbo-Gear. It is manufactured by the Poole Engineering Co., Baltimore, Md. The Turbo-gear operates without noise or vibration and will drive in either direction of rotation without necessitating changes in the machine. It can be furnished at any ratio from 4 to 1 and in any size from 1 to 20,000 HP.



CRUSHING OUTFIT HAS GRIZZLY SCREEN FOR SEPARATING MATERIAL.

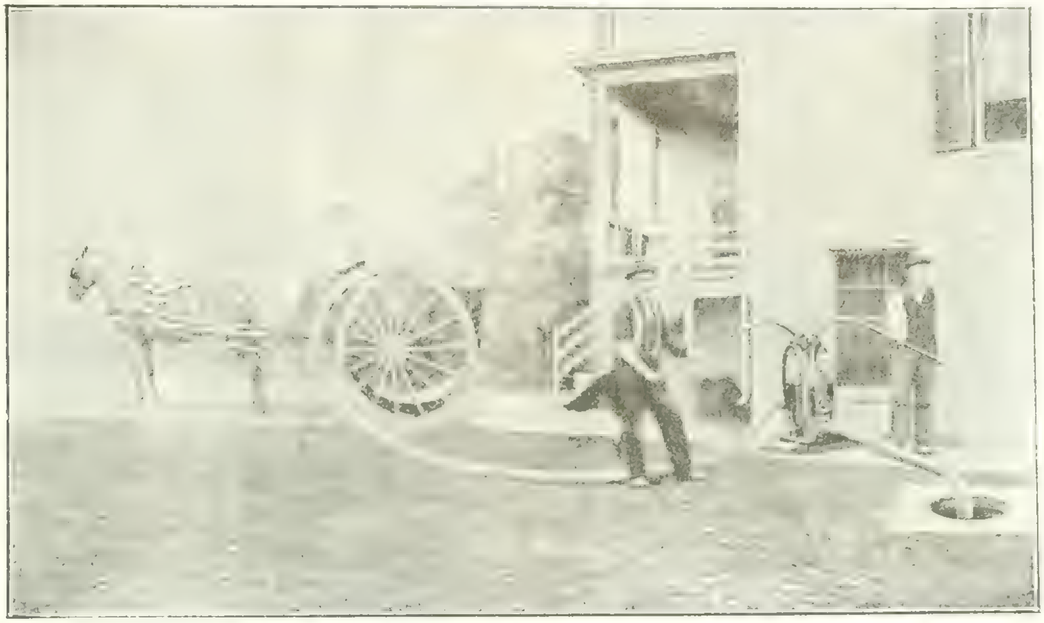
The Western Wheeled Scraper Co., Aurora, Ill., has, for several months past, been furnishing for its different sizes of crushers an improvement which seems to meet with much favor with the users. This device consists of a gravel feeder, crusher, elevator and screen. The improvement consists in the introduction of a grizzly screen which receives the product and separates from the material requiring crushing, delivering the same from the chute screen directly into the elevator buckets, the over-size going directly to the crusher. Where the fine product is run through the crusher together with the coarser material, the capacity of the crusher is greatly reduced as the fine product will require as much time or more in passing through the crusher as does the coarser product. The gravel in the bank is delivered into the gravel feeder either by hand shovelers or with team and drag scrapers. The lower end of the gravel feeder, being bridged, the product is either dumped through the trap from the scrapers of from a small dump car, the last named process being more economical than hand shoveling.



Portable Crusher Outfit With Gravel Feeder, Elevator and Screen.

SPECIAL OUTFIT FOR EMPTYING CESSPOOLS, VAULTS, ETC.

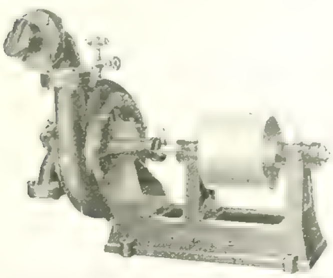
A special outfit for use in cleaning out cesspools, vaults, catchbasins, etc., has been brought out by George H. Holzbog & Bro., Jeffersonville, Ind. The outfit is a combination of the standard Holzbog cart and an Edson diaphragm pump. The method of operation is shown in the illustration. The cart has a capacity of 2 cu. yd. It carries a specially shaped steel air and water-tight tank, fitted with two lids, one in front and one in the rear. The cart has a low hang which makes it easy to load and to dump. The distance from the ground to the top of tank is only 51 in. The tank is well balanced and as it is adjustable at any angle, the load can be completely discharged without the necessity of raking. The dumping is done by a simple gear arrangement. The diaphragm pump has a 3-in. suction and discharge and weighs 270 lb. The entire pumping outfit includes strainer, couplings, the necessary suction and discharge hose, etc. The pump, hose, etc., can be detached from the cart, permitting the latter to be used for collecting and hauling garbage or other material.



Special Sanitary Outfit Cleaning Out Cesspool.

PUMP FOR SAND AND GRAVEL WASHING PLANTS.

A centrifugal pump designed for heavy duty in connection with gravel and sand washing plants is illustrated below. The pump is of the overhung type. The suction flange and head are removable thus making it easy to thoroughly clean the suction side of the impeller. The suction elbow is fitted with a hand hole plate for use in removing materials that may clog the intake side of the propeller. The casings are thick and heavy at the wearing surfaces. The impellers are of cast steel and of the enclosed type. The pump is furnished for either belt or direct drive. This pump is manufactured by the Advance Pump and Compressor Co., Battle Creek, Mich.



Pump for Sand and Gravel Plants.

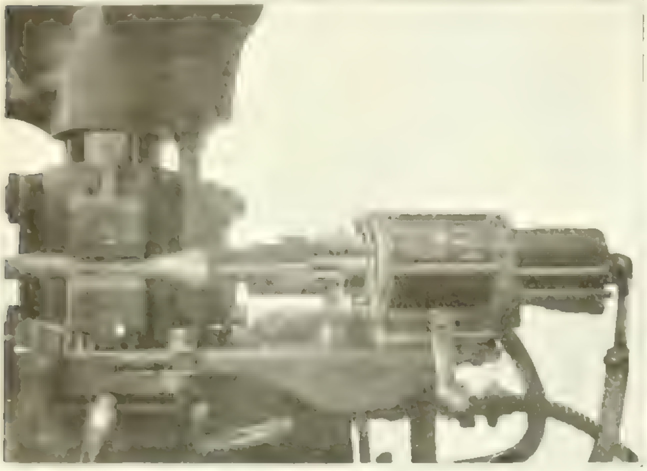
MULTI-USE PORTABLE PUMPING OUTFIT.

A portable pumping outfit of particular usefulness for cleaning catch basins, but adaptable to many other operations, should be of interest to municipal officials. An outfit of this kind is illustrated below. The pumping apparatus is mounted on a special Kelly-Springfield chassis. In cleaning catch basins the large suction hose is attached to the suction chamber and the free end of the hose is placed in the basin. A pipe permits the overflow water to run back into the sewer as the water in the tank is replaced by solids. The pump forces the water from the previously primed tank through the sediment chamber, creating a suction which elevates the debris from the basin into the tank. The apparatus also can be used for spraying or sprinkling plants, trees and lawns, for cold water painting or disinfecting or for long distance pumping. The outfit is so designed that it can be readily converted into a motor truck apparatus. By adding certain appliances the outfit can be used for street sprinkling and flushing. This portable pumping apparatus has been placed on the market by the Springfield Engineering Co., Bushnell Bldg., Springfield, O.

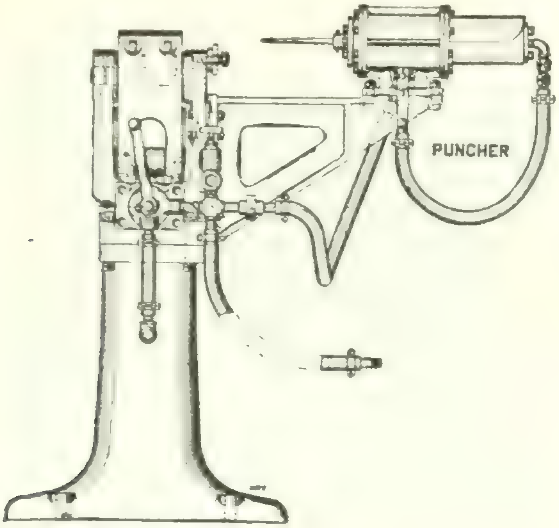
Special Portable Pumping Outfit in Use in Cleaning Catch Basins.

PNEUMATIC PUNCHING DEVICES FOR DRILL STEEL.

A pneumatic device for opening up the hole in the end of a piece of steel while being worked into a bit or leg was placed on the market last year by the Denver Rock Drill Manufacturing Co., Denver, Colo. This device is called the Model 10 "Waugh Drill Steel Puncher" and is designed to be mounted on the pedestal of the company's Model 8 "Waugh" Sharpener directly in the rear of the vise jaws. The punch is held in a tapped chuck and is hammered into the steel as it is fed forward by an air feed cylinder. The operation is very simple and it is stated the punch will open up the water hole in a shank or bit in one-twentieth the time required to do it by hand. The Denver Rock Drill Manufacturing Co. also brought out this puncher mounted on a separate pedestal. This later combination, known as Model 110, is designed particularly for enterprises where large quantities of drill steel are handled daily, and where it is desirable to expedite the work by separating the hole punching from other operations. The Model 110 "Waugh" Drill Steel Punching Machine comprises a practical air feed puncher, substantially mounted on a bracket attached to a pedestal containing an air operated vise. The control of the puncher is separate and distinct from that of the vise. The puncher embodies the same principle as the air feed stoping drill. The punch is struck by a rapidly oscillating piston hammer of the valveless type. The whole mechanism is mounted in an air feed cylinder and is controlled by a simple lever at the base of the cylinder.



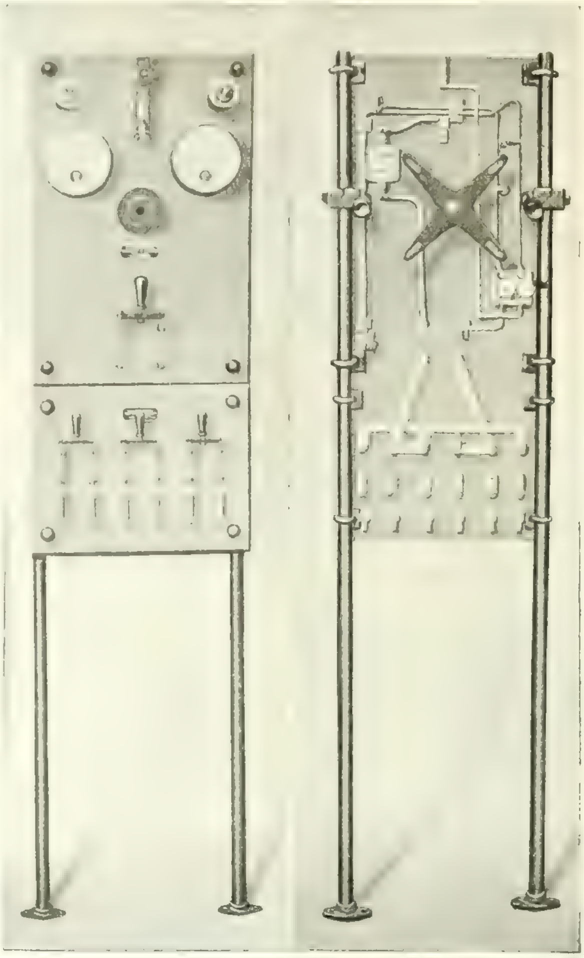
Model 10 Waugh Drill Steel Puncher Mounted on Sharpener.



Model 110 Waugh Drill Steel Punching Machine.

READY TO WEAR SWITCHBOARDS.

The installation of the old types of switchboard involved a great deal of detail work. First of all, each piece of detail apparatus must be ordered with careful consideration given to the type and capacity. Drilling templates of each must be secured and considerable sum must be allowed to cover investment in machines and tools for drilling the slate and bending the copper strap connections. Finally, when the panel is built up and installed, it may operate and it may look pretty good, but one cannot be absolutely certain. A switchboard which eliminates many of the installation difficulties is illustrated. This switchboard is particularly adapted for smaller installations, and is suitable for the control of a direct-current generator and three lighting circuits. One feature of this type of switchboard that is particularly in its favor, is that it can be placed in operation by simply connecting the leads from the generator and feeder circuits to the terminals provided for that purpose.

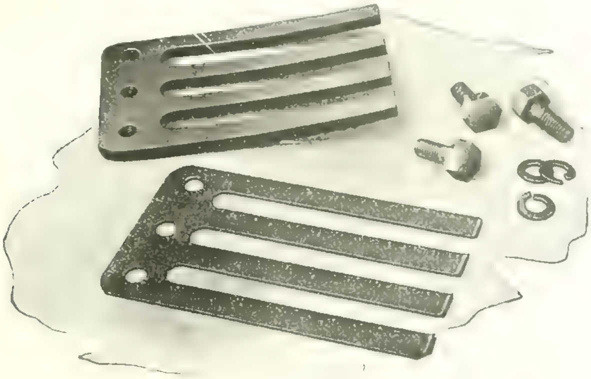


Front and Back Views of K. D. Panels.

The accompanying illustration is typical of the types K.D. and J.D. panels, both of which are suitable for 125 and 250 volts installations up to 600 amperes capacity, which are manufactured by the Westinghouse Electric & Mfg. Co. at East Pittsburgh, Pa. Both the K.D. and J.D. type of panels permit a choice in number and capacity of feeder circuits.

SULLIVAN STRAIGHT LINE COMPRESSOR NOW EQUIPPED WITH PLATE VALVES.

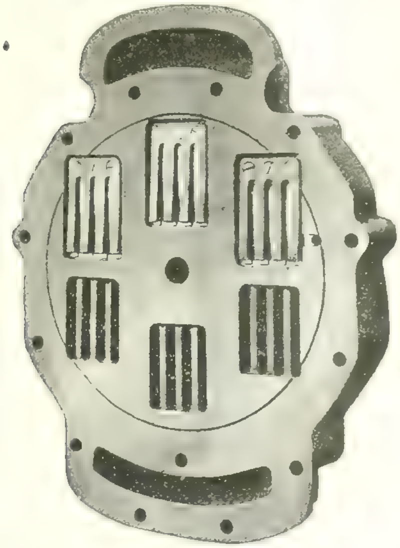
During the past year a radical improvement has been made in the design of the Sullivan straight-line steam-driven two-stage air compressor, which will be of interest to contractors and engineers. This consists in substituting for the semi-rotary or corliss mechanically driven air inlet valves, formerly employed on these machines, the new type of Sullivan plate valves.



Sullivan End Rolling Finger Valve and Guard.

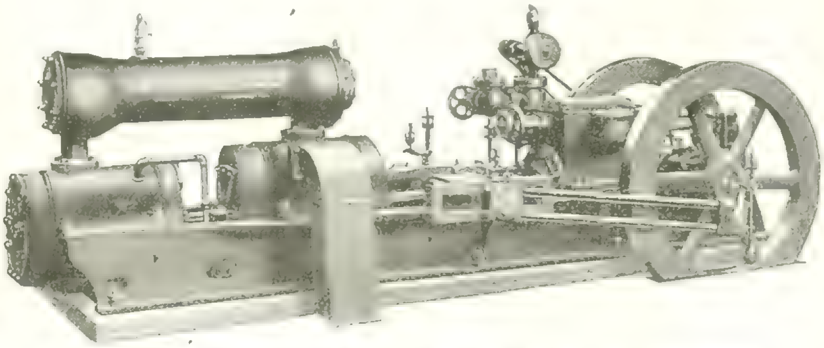
These valves, which are similar in design to those in successful use the past two years on Sullivan angle-compound compressors, are shown by the accompanying illustrations. They secure rapidity of action, wide port opening, with minimum wire drawing effect, a reduction in motive power, and fewer moving parts. They are accessible for inspection or removal, strong and durable, and require no care or attendance. Excellent volumetric efficiency is secured, the factors of loss from clearance and leakage in this design being comparatively low.

The Sullivan finger valve is of a distinctive grid form, shaped like a group of thin flat fingers or blades, and made from special sheet spring steel. These valves are bolted at one end only to a steel guard plate, the other end being free. This guard plate is curved to form a rest for the entire length of each blade, when it is bent or lifted by the incoming or outgoing air. In lifting, under air pressure, the fingers exercise a rolling or rocking action against the guard, opening first at their outer end; in closing the fingers roll back to their seats, the fixed end closing first and the free, outer points last. The end rolling action is free from bodily lift that would produce a hammering or slapping effect. The idea for these valves was obtained by the Sullivan engineers from the familiar band saw, which is continually bending and straightening again around its pulleys. As the radius of curve of the valve guard plates is much longer than that of the pulleys, the durability of this form of valve, made of band saw steel or its equivalent is evident.



Cylinder Head Showing Inside Face. The Inlet Valves Are Above.

The valves seat over rectangular slots or ports in the face of the cylinder heads. The inlet valves are situated in the upper half of the head, and the discharge valves, which are of the same design, in the lower half. An improved and simplified steam valve mechanism, controlled by a Meyer adjustable cut-off, and a new and improved pressure and speed regulator, form other desirable features in these Sullivan WB-3 compressors as now furnished. These compressors are built in capacities, ranging from 400 to 950 cu. ft. per minute.



Sullivan W B 3 Straight Line 2-Stage. Steam Driven Air Compressor.

NEW END SUCTION CENTRIFUGAL PUMP.

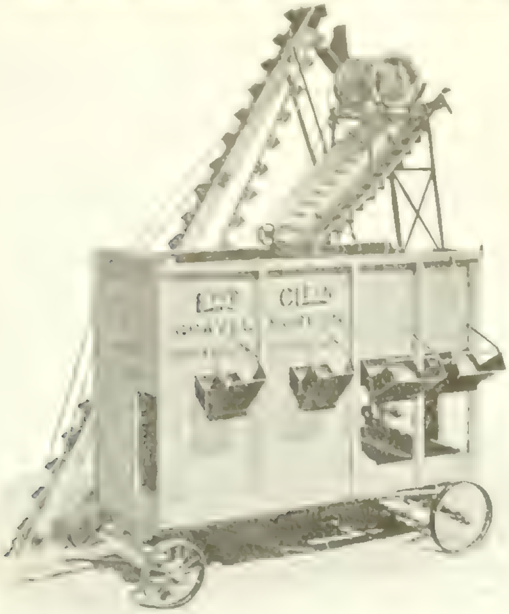
One of the 1918 developments of the Wheeler Condenser & Engineering Co., Carteret, N. J., is their new end suction centrifugal pump. It is of special interest because of the unusual position of the suction opening. This opening is directly beneath and parallel to the end bearing. In this position it is out of the way and yet it is in a convenient position for the erection men, for inspection, for upkeep, etc. This arrangement makes it possible to place a pumping unit in a room of small area—considerably smaller than where the suction end is opposite the outlet end, as is the most common practice. In many cases this also facilitates the making of pipe connections, sometimes saving elbows and reducing the length of piping.

TRACTION MACHINE FOR UNLOADING LOOSE MATERIALS FROM GONDOLAS.

A machine for unloading sand, gravel, crushed stone or other loose material from gondolas has been brought out by the F. C. Austin Co., Inc., Chicago. The material is lifted by a 1½-yd. clamshell bucket to a 2-yd. storage hopper from which it is discharged into the wagon or truck. The normal loading reach is 11 ft. from center line and the maximum loading reach is 16 ft. The over-all width of the machine proper is 10 ft.; over-all height is 25 ft. and over-all length is 13 ft. 7 in. The total weight is 5 tons. The power is supplied by a 15 H. P. gasoline engine. The machine is mounted on traction wheels with rear axle drive and front steering wheels. The propelling speed of the traction device is 1 [illegible] miles per hour.

GRAVEL SCREEN WORKS ON NEW PRINCIPLE.

A screen that is claimed to effectively screen gravel regardless of weather conditions has been brought out by the [illegible] Manufacturing Co., Charlotte, Mich. In this outfit (see Fig. 1) the pit run gravel is carried up by elevator and deposited in a chute whence it slides into stone drum. The grovel and sand pass through the large holes and drop on the screen. The large stones pass out the [illegible] end into a [illegible] which carries them over the team track. The screen consists of a series of perforated steel plates hinged at each end to sprocket chains. These screen plates travel slowly upward, presenting a surface for the gravel to travel over. When the screen plates reach the top they tip bottom side up and strike a spring bumper that removes anything that may be clinging to them. The material is usually scraped into the boot of the elevator by teams. Several of the screens, however, are being operated in connection with a drag line. Figure 2 shows one of these screens installed near Ionia, Mich. The road commissioner in charge of this work reports he has kept 35 teams busy hauling away sand and gravel from this outfit.

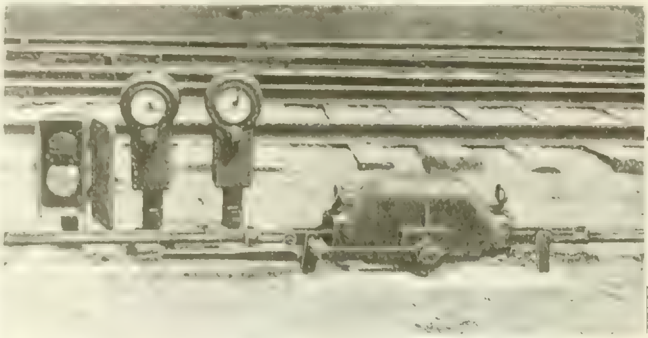


The "Ever Clean" Gravel Screening Outfit.

Gravel Screening Outfit at Work Near Ionia, Mich.

SAFE LOCK SWITCH MACHINE.

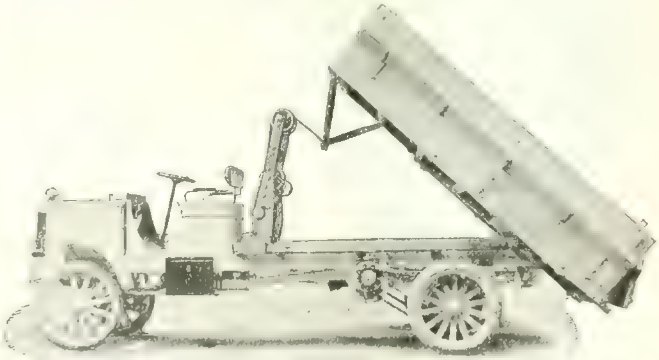
A safe lock switch machine that combines in one unit the operative levers and facing point levers for any combination of functions which are ordinarily connected to one lever of a mechanical interlocking machine, as, for example, a single switch, single or double slip switch or a switch and derail, is illustrated. Some of the advantages claimed for this machine are: Its use adds to the safety of operation; when applied to a crossover, one operation of the lever unlocks, throws and relocks both switches, thus insuring safe and expeditious handling of cross over movements. The machine has only three working parts and standard interlocking material is used, thus eliminating ordering or carrying in stock special material. The mechanism and parts are reversible to meet any conditions and are enclosed in weatherproof iron case. The moving parts work in oil contained in the machine case. The machine is manufactured by Safe Lock Switch Machine Co., 414 Curry Ave., Lexington, Ky.



Safe Lock Switch Machine.

TRUCK BODY THAT DUMPS TO REAR OR TO EITHER SIDE.

A truck dump body that can unload from the rear or from either side is particularly useful in construction operations. A body of this kind has been placed in production by Lawrence Bruder, 211 West Second St., Cincinnati, O. This body is equipped with a specially designed hand power hoist. This hoist is applicable to any make of truck and is made in various capacities from 1 to 5 tons. The gears are so arranged that a 5-ton load can be dumped with very little effort in less than 3 minutes. A dump body that unloads only from the rear is also manufactured by this firm. Both types are made of wood or steel, or wood with steel bottom. The illustration shows a 4-ton rear dump wood body with patented hoist mounted on a Packard truck. In the case of the body illustrated the hoist takes up only 12 in. of space in back of the driver's seat.



4-Ton Wood Dump Body on Packard Truck.

DITCHING AND BANK BUILDING ATTACHMENT FOR JORDAN SPREADER.

Of the new time- and money-saving devices added to railway construction practice and maintenance of way equipment during the past twelve months the ditching and bank-building attachment for the Jordan spreader is of particular interest. The Jordan spreader is extensively used in ditching projects and for the removal of snow from railroads. Addition of the improvement to the spreader enables the machine to produce by speedy mechanical action accurate cross-sections in ditching and bank forming. Another important point, besides the ability to produce and preserve a permanent cross-section, is that once the cross-section is obtained the attachment may be employed to remove snow from it. A speed of from 3 to 12 miles an hour, depending on the nature of the operation, may be obtained by means of the new attachment. In certain classes of work now done by gang labor the time element is reduced from a week to as low as a few hours, a factor that is important when speed is desired; and last, but not least, there is the payroll saving gained.

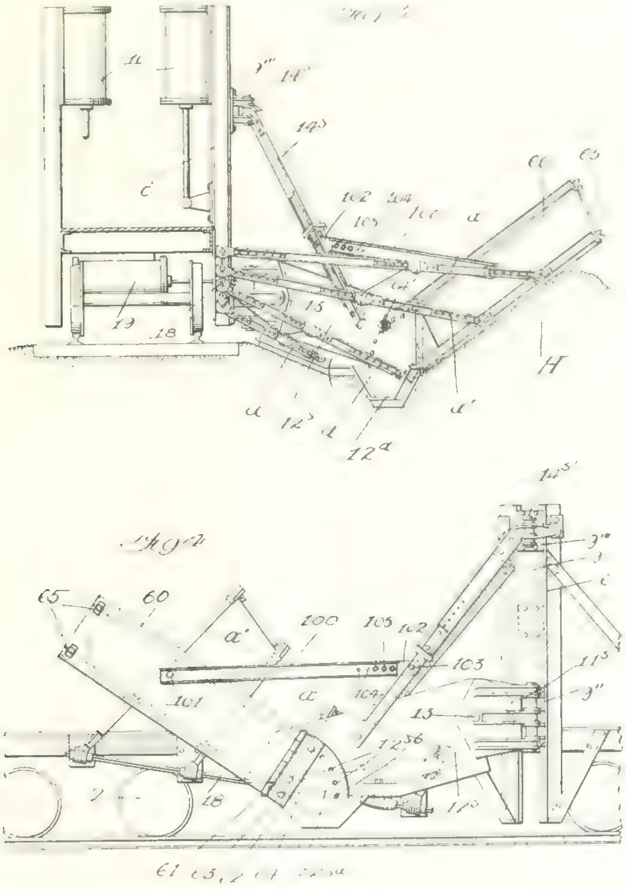


Illustration No. 1.

The ditching and bank-building attachment for the Jordan spreader is applied in place of one of the large wings on the side of the spreader for which it is made,, and may be attached to any one of the steel Jordan spreaders now i nuse. It is made of materials of the same strength as the regular wing and will move any material that could be moved by the regular wing. The operation—opening and closing, raising and lowering—is by means of air from the train line, the same valves being used as with the regular wing.

The attachments are made to order to shape the ballast section and form the ditch and bank desired, and may be made to form any cross-section up to 19 ft. from center line of track and to cut a ditch with a maximum depth of 3 ft. below the top rail. By building a special spreader it is possible to form a ditch 4 ft. below the top of rail. These attachments may be used to form ditches by two methods: one in deep cuts; the other in shallow cuts up to 7 ft. in depth.

Method of Forming Ditches in Deep Cuts.—In the illustration No. 1, Fig. 2, shows a side view and Fig. 3, a rear view of the ditching attachment in operation as for forming ditches in deep cuts. The method used is to open the wing and lower it enough so that the pocket formed by the templet or ballast and ditch forming wing, number 12s in the illustration, and the carrying or outer wing, number 60 in the illustration will be filled up by pushing the spreader through the cut, repeating this, dropping the wing lower each time until the desired depth is reached. This pocket will hold from 6 to 10 cu. yd. of material, dependent upon the width of cross-section of road bed formed. It is stated that this work may be accomplished at a rate of speed of about 10 miles per hour. The material is disposed of by allowing it to waste out under the carrying wing on fills at the end of cuts or in case of a level stretch it is left in piles to be later removed by plowing with the ditcher arranged to work by the second method, which will be explained further on. The carrying or outer wing, number 60, is 3 ft. wide an approximately 10 ft. long, the length varying slightly with the length of ballast-forming wing.

In the illustration No. 1, Fig. 2, number 62, represents the brace connecting the carrying wing, Number 60, to the front of the car; number 63, the joint in this brace to allow vertical movement; and number 65, the connection between the brace and the carrying wing, this joint being also the hinge for the horizontal movement; number 68, a chain used to support the front end of carrying wing to keep it from going to too great a depth.

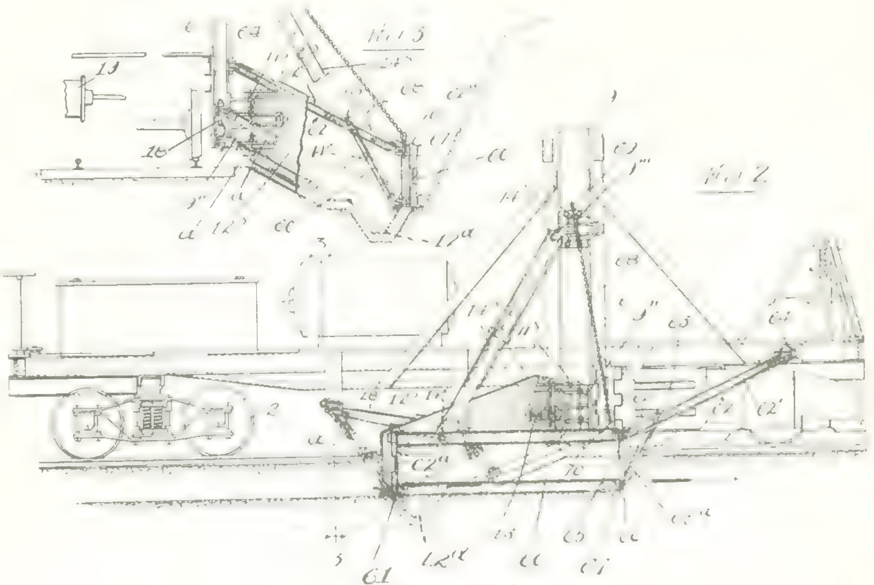
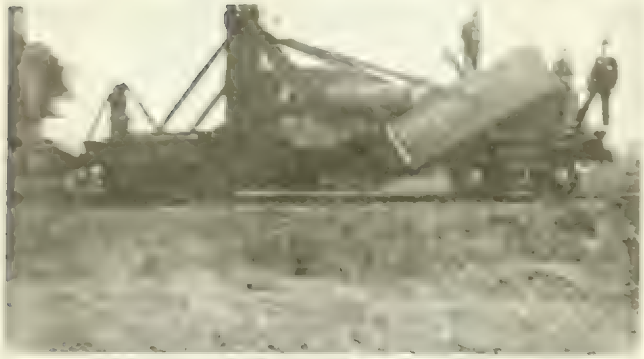


Illustration No. 2.

The [illegible] to hold the cutting wing down to its work. [illegible] of the [illegible] with the regular wing.

Method of Forming Ditches in Shallow Cuts.—In [illegible] ditches in cuts [illegible]

[illegible] tcher by this method it is possible [illegible] to take two or three cuts [illegible] three cuts generally being the most required, so that it is possible to form ditches by this method at the rate of about 2 or 3 miles per hour for one side of the track.



Ditcher Built for Iowa Railway & Light Co.

The outer wing is adjustable from horizontal up to a one to one slope and is the same wing as the carrying wing used by the first method of ditching, arranged for plowing by swinging wing around into a straight line with the templet or ballast-forming wing and the outer end raised to the desired height and secured by means of the diagonal brace, as at number 100, Fig. 4, illustration number 2, and by meeans of the p[illegible] number 04, Fig. 4, illustration number 2, and is he[illegible] out when at work by means of braces "a," Figs. 3 a[illegible] 4, parts of these braces being special and furnishe[illegible] with the ditching attachment.

[illegible] wing may be removed from the spreader and the ditching attachment applied in abo[illegible] 4 hours by 6 men if a means of handling the parts b[illegible] power is available; and the attachment may be changed to operate from one method to the other by 4 men in two hours if power is available. If no power is avai[illegible]able it will require 12 men to do either job and w[illegible] take about the same length of time.

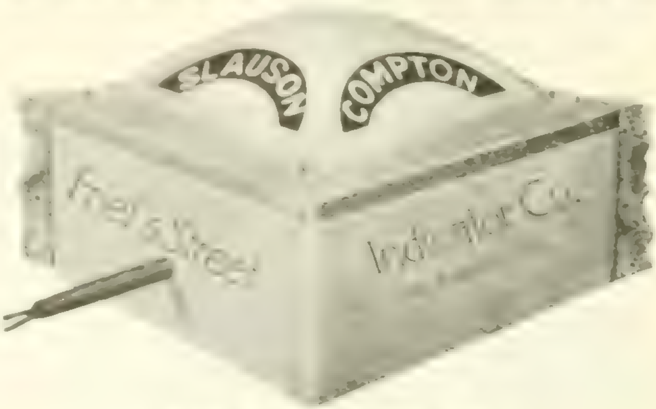
With this attachment, it is claimed, a uniform cross-[illegible] mum expense and a new ditch may [illegible] places at a very low cost.

The half-tone illustration shows a ditcher, side vie[illegible] wing closed, manufactured for the Iowa Ry. & Lig[illegible] Co., for use on the Wyoming Ry., arranged for forming ditches in cuts up to 7 ft. in depth.

The ditching and bank building attachment was invented by Robert E. Bressler, Manager and Chief Engineer of the O. F. Jordan Co., East Chicago, Ind., manufacturer of the Jordan spreader. It is being mar[illegible]

A COMBINED TRAFFIC BUTTON AND STREET SIGN.

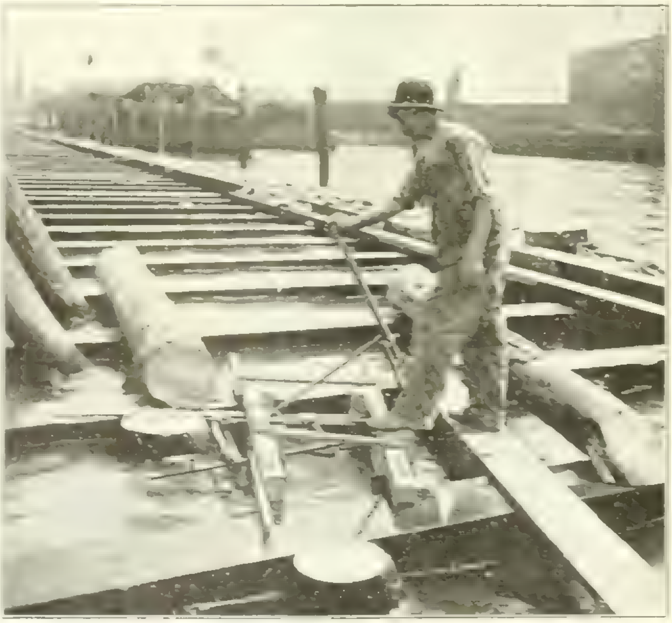
A type of warning sign that is finding favor on the good roads of the Southwest is shown in the cut. It serves every purpose as a traffic and street sign both [illegible] red light in every direction and the street names are easily read from the sidewalk or passing automobiles. No damage results to button or car when driven upon as it stands only 4½ in. above the pavement. Many tests and long usuage prove that the glass signs are thoroughly protected by the recesses. The inventor is Grant Friel, 215 Stimson Bldg., Los Angeles, Cal.



Traffic Button and Street Sign

ONE-MAN PILE CUTTING SAW.

A hand operated pile cutter that will cut off an average pile about three times as fast as it can be done by two men with a cross cut saw is an innovation that will be appreciated by contractors. Such a rig has lately been placed on the market. The machine weighs 58 lb. and can be handled by one man for all ordinary purposes. In the illustration the piles are being cut at water level. The contractor has thrown together a cradle of rough lumber which holds the machine at the exact level required for the work. This saw rig is manufactured by the Forest King Corporation, 150 Nassau St., New York City.



A One-Handed Job with the Forest King

A LIGHT EASILY PORTABLE SHOVEL, STRONG ENOUGH FOR HARD DIGGING.

[illegible] ½ cu. yd. Erie shovel, which was placed on the market [illegible] The entire machine is designed and built to operate its ½ yd. dipper in hard material, without undue strain on [illegible] cu. yd. per hour in deep cuts, and 15 to 25 cu. yd. per [illegible]

[illegible]

[illegible] been favorable to larger yardage. The attainable working [illegible] per minute, although the average speed under actual [illegible] ute. It makes a cut 28 ft. 4 in. wide on floor level, or [illegible] horizontal. The height of dump can be increased be[illegible] and without planking. It will cross an ordinary county [illegible]

PNEUMATIC PAINTING EQUIPMENT

[illegible] hand brushing system, but it also is claimed to give [illegible] painting outfit, adapted for both field and shop use. [illegible]

[illegible] in. heavy rubber air hose with the necessary renew[illegible] for attachment by hose connection to the compressed [illegible] pressed air suitable for operating the painting equipment [illegible] to furnish either gasoline engine or motor-driven air [illegible]

[illegible]

[illegible]

MAN HOIST FOR DUMP BODIES

[illegible]

[illegible] bodies that will fit any [illegible] ed in a few minutes without drilling holes into the frame is illustrated. It is claimed that this hoist easily handles load[illegible]

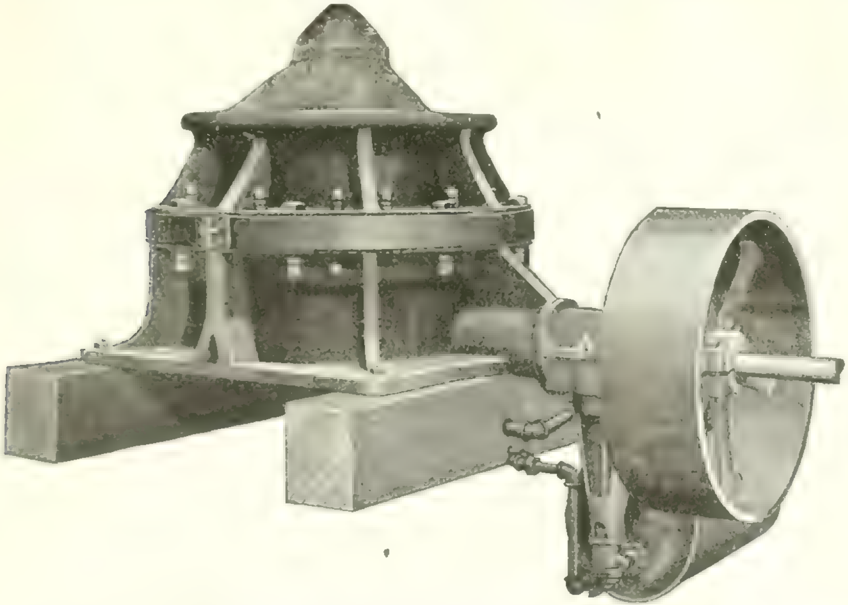
NON-SKID CHAINS FOR MOTOR TRUCKS.

A tire chain designed especially for power truck use is shown in the accompanying illustration. The advantages claimed for this device are: The chains are held securely across the tread of the tire so that the wear is over a considerable area; they can be put on or taken off from a wheel in 1 minute without jacking and without requiring the use of tools; they are adjustable to length; the breakage of one chain does not materially lessen the degree of protection. The chains are made in different sizes and types to fit practically all forms of wooden and steel wheels, either spoked or disc. The chains are manufactured by the Challoner Co., Oshkosh, Wis.

This Type of Clamp Will Fit Over 165 Makes of Trucks.

A NEW REDUCTION CRUSHER.

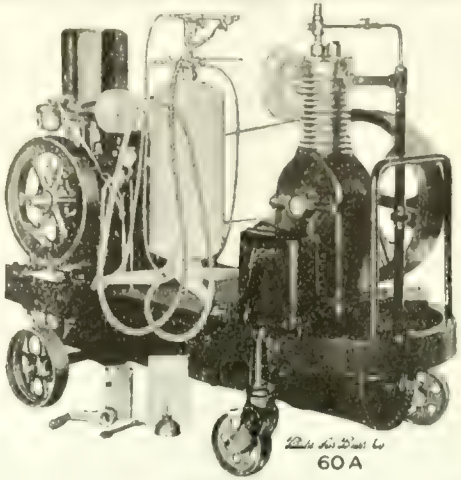
A "follow-up" crusher that is claimed to simplify a rock-crushing plant to a remarkable extent is illustrated. This is the No. 4 Telsmith reduction crusher. It is a very short massive machine of the gyratory type, designed to follow a No. 7½, 8 or 9 gyratory breaker and to re-crush down to ¾-in., 1 in. or 1½-in. size. As an example of plant simplification, it is stated that one No. 9 Telsmith primary breaker, followed by two No. 4 reduction crushers, will handle 300 cu. yd. of rock per hour, crushing the whole output from steam shovel size down to 1 in. The reduction crusher is an adaptation of the Telsmith rigid shaft breaker. The chief point of difference is in the head, which is made low and flat. The frame is cast in two pieces, walled and ribbed to withstand enormous strains. The top spider is cast into the upper section of the frame. The spider arms are very short and heavy and the bottom spider is cast into the lower section of the frame, with big arms and a huge hub. The Telsmith reduction crusher is made by the Smith Engineering Works, Milwaukee, Wis.



The Telsmith Reduction Crusher.

PAINT SPRAYING EQUIPMENT.

The labor saving advantages of applying paint by spraying is well indicated by a comparison made recently between hand brushing and air brushing in estimating for the Government on the painting of 5,000,000 sq. ft. of concrete buildings in two coats. It was shown that 17 or 20 air brush operators could cover the surface with two coats in 60 days, while to do the work by hand in same time would necessitate the employment of approximately 84 men. This indicates that one man with an air brush on this particular work could accomplish more than 4 men using hand brushes. A portable air brush outfit is illustrated below. This outfit has sufficient capacity for two or three painters. It consists of a 3-HP. gasoline engine or 3 HP. electric motor, 4½x4½ air cooled compressor, 20-gal. pressure tank, 8-gal. painting unit, air brushes and 25-ft. hoses. The shipping weight is 1,250 lb. The small illustration shows an outfit designed for painting tanks, smokestacks, etc. This painting equipment is manufactured by the Paasche Air Brush Co., Chicago, Ill.

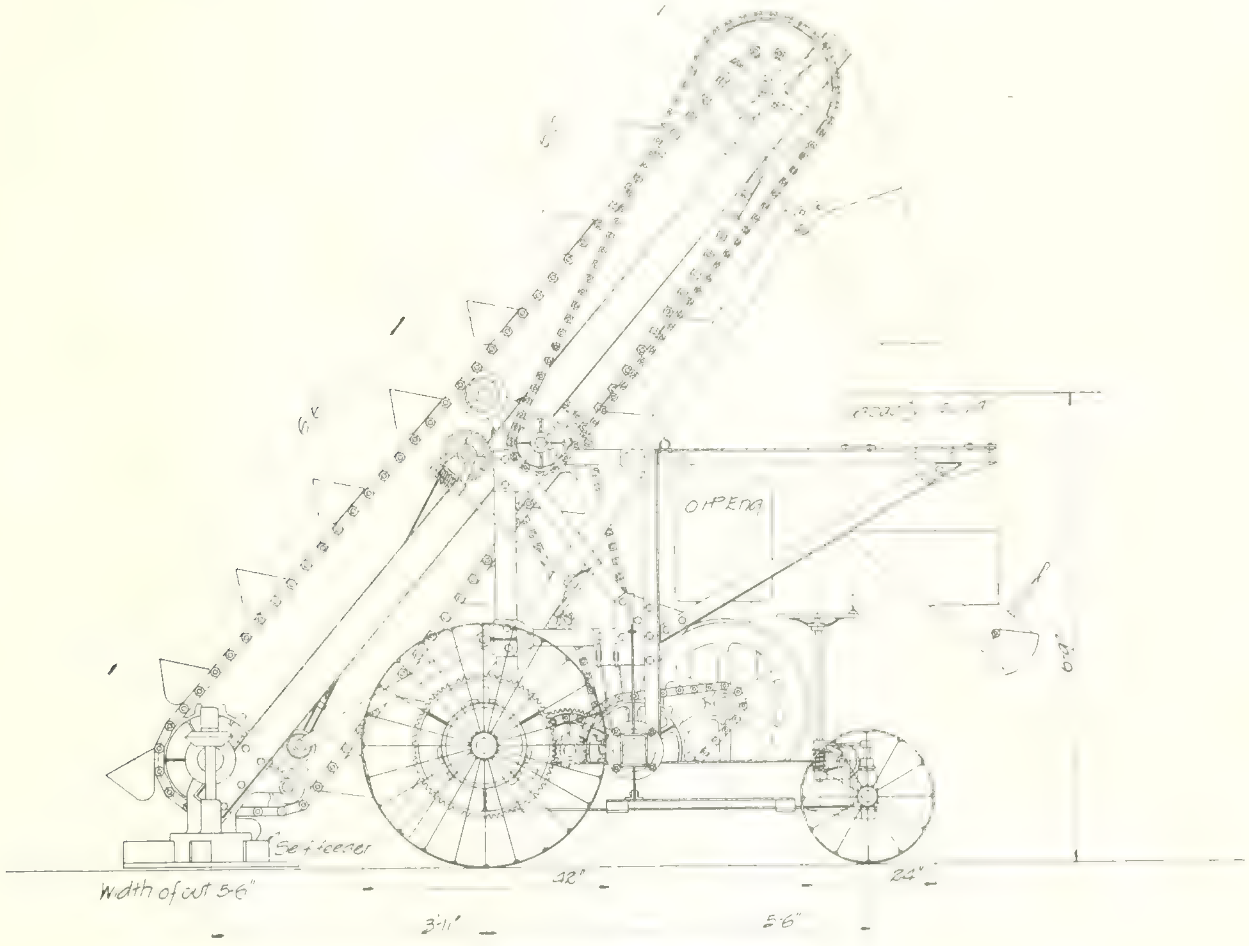


Portable Painting Outfit Used by Large Painting Contractors.

Stack Painting Outfit.

SELF-FEEDING MACHINE FOR LOADING BROKEN STONE, GRAVEL AND OTHER LOOSE MATERIALS.

A multiple bucket type loader with self-feeding device is illustrated. The feeding device consists of two eccentrically mounted discs that continually sweep through the pile of material to be loaded with a range of cut 5 ft. 6 in. wide. Mounted over these discs are a series of curved feeding blades that carry the material from the pile to the bucket line automatically withdrawing from the load so that the buckets have a clear sweep across the discs for loading. These feeding blades cut through the material pile continuously, forcing the same into the bucket path. The elevator proper is arranged for vertical movement both for cutter adjustments and folding back in traveling for shipping clearances. The power plant consists of a 10 H. P. engine hopper cooled type and operating machinery consists of a direct drive chain and gear transmission, giving elevator operation and two speed and reverse traction. The low or feeding speed is provided for use under working conditions, while the high is for traveling. The working speed is to be 50 ft. forward and 25 ft. into pile per minute; the traveling speed 140 ft. per minute forward; 70 ft. reverse. The loader is lb. This loader is sold by the F. C. Austin Co., Inc., Chicago.



Austin Self Feeding Loader.

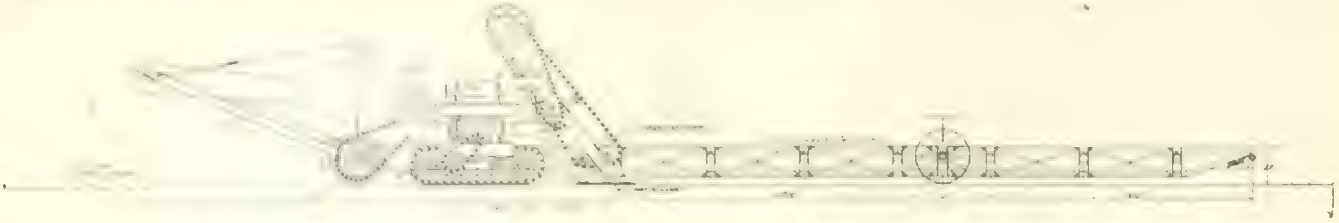
DROP FRAME TRAILER.

A trailer with drop frame that makes it particularly useful for carrying heavy machinery or light, bulky merchandise and for garbage and ash collection purposes has been brought out recently by the Lee Loader & Body Co., Chicago. Except for the frame, the Lee standard reversible trailer design is followed in the new trailer. The frames are built up of plates and angles like a bridge girder. The frames are hot riveted, the flange rivets being driven with an air operated compressor. These trailers, equipped with water tight dump body, are used for garbage collection in many cities. Indianapolis, Ind., for instance, is employing 24 of these vehicles for this purpose. The trailers are built in $2\frac{1}{2}$, $3\frac{1}{2}$, $4\frac{1}{2}$ and 6-ton capacities. The last mentioned has a plain wood platform and is designed principally for hauling heavy machinery, blocks of stone or in fact almost any commodity of great weight where saving of time and energy in loading and unloading is of vital importance.

Drop Frame Trailer and Dump Body as Garbage Vehicle Has Advantage of Easy Lift and Low Load.

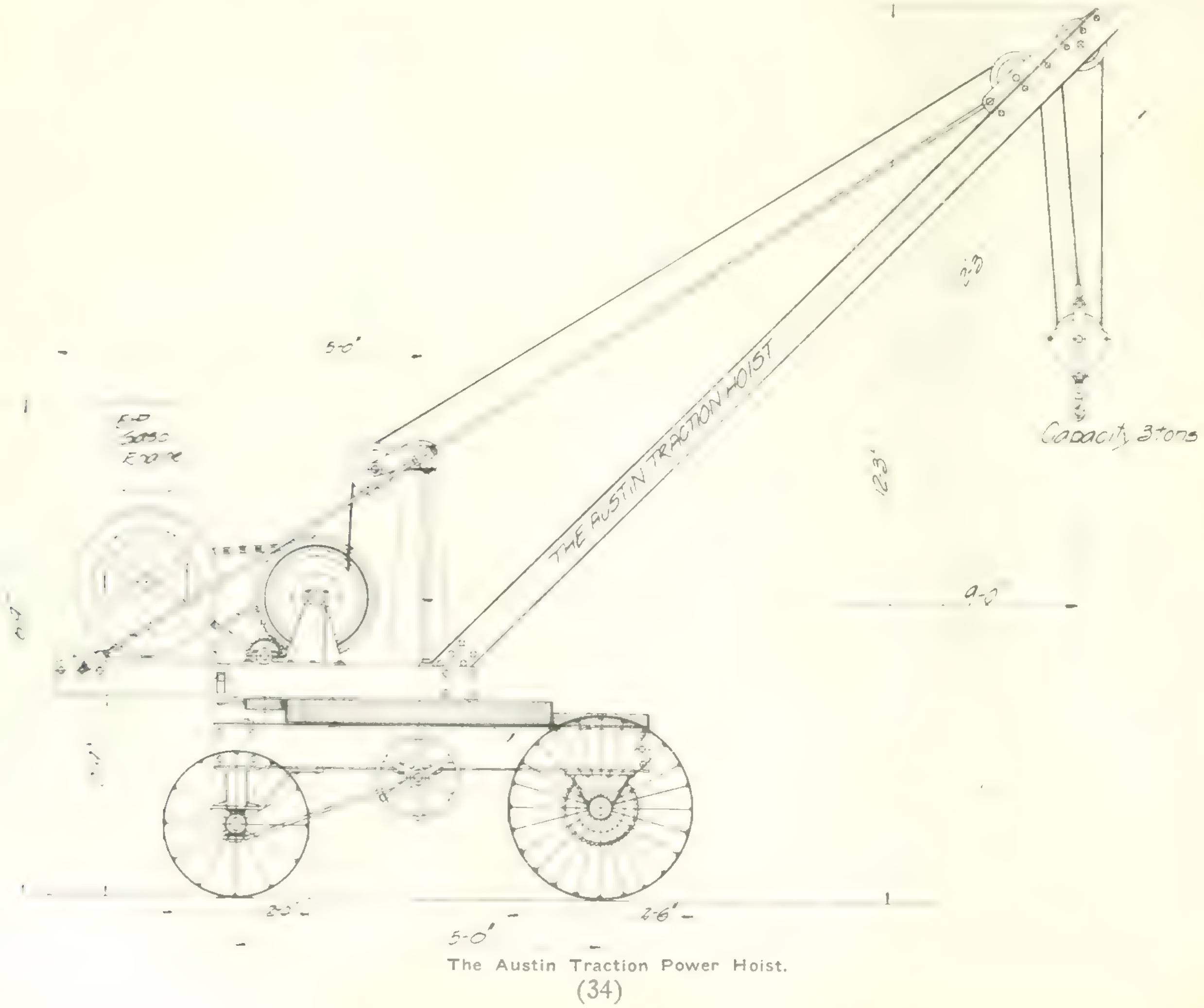
AUTOMATIC MIXER LOADER REQUIRES NO SHOVELERS.

A mixer loader that eliminates shovelers has been brought out by the F. C. Austin Co., Inc., Chicago. The loader, because of its power shoveling and measuring machines, requires only three men for its operation, and it is claimed that it will load and deliver more material in accurate measured batches than can be run through the mixer at capacity. The action of the loader is as follows: A continuous running belt conveyor, operated by a gasoline engine, is arranged to feed the concrete mixer loading skip or hopper. The material is arranged in wind-rows either side of the belt conveyor on the road to be paved and Austin automatic oscillating shovels are arranged on either side of the belt conveyor and in front of the material wind-rows. The shovels work back and forth through the material piles arranged automatically according to their widths with the Austin self-feeding loader for the buckets. This loading device consists of two eccentrically mounted discs that continually sweep through the material with a range of 5 ft. 6 in. Mounted over these discs are a series of curved feeding blades that carry the material from the pile to the bucket path automatically withdrawing from the load so that the buckets have a clear sweep across the discs for loading. The shovel rapidly eats away the material pile and advances forward continually. The measuring hopper is fed from the shovel by means of a belt taking the load of the buckets. One man located between the two shovels trips the measuring hopper doors and allows the measured material to be discharged onto the continuously running conveyor which carries the aggregate into the mixer loading hopper or skip. The loader is adapted for use either with the end loading paving mixers or with side loading mixers.


Austin Mixer Loader.

LIGHT SELF-PROPELLED POWER HOIST.

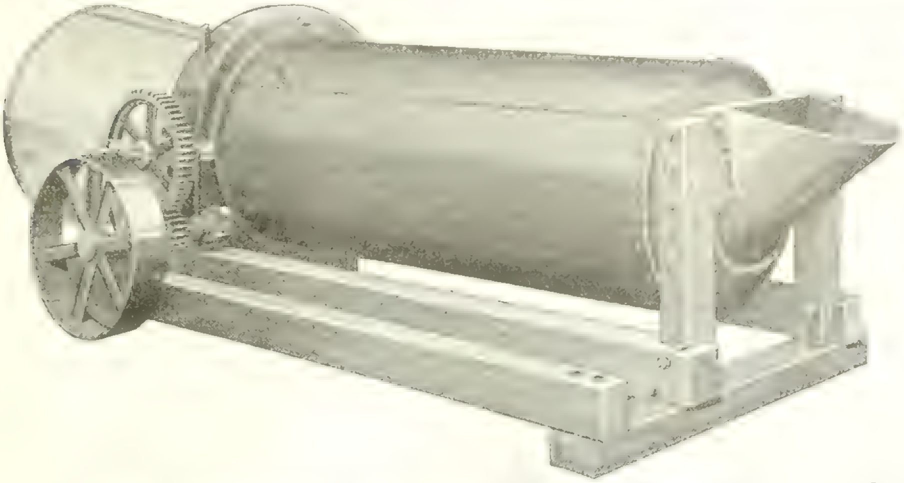
A self-propelled light weight power hoist that is capable of hoisting and carrying a load of 3 tons at a 9-ft. radius is illustrated. The power plant consists of a 6 H. P. hopper cooled gasoline engine with friction clutch controls for hoisting, swinging and traveling. The fuel estimate is 6 gal. of gasoline per 10 hours. The traction speeds are 1 mile per hour on high and ½ mile on low. The shipping weight is 5,650 lb. The F. C. Austin Co., Inc., Chicago, is the manufacturer.



The Austin Traction Power Hoist.

PORTABLE GRAVEL WASHER.

The value of a good gravel washer is often not appreciated. Building contractors, cement block plants and road makers often pass by a local deposit because it contains a little clay or loam. A machine for cleaning this dirty gravel is illustrated below. This is the Telsmith gravel washer. It consists of a cylinder with end spiders turning on a central shaft. At one end this shaft is supported by a bracket casting, which also supports the feed chute. At the discharge end the drum is driven by a girth-gear, journalled in a circular housing which completely encloses gear, pinion and bearing. The central shaft is supported at this point by the end-spider. The drum is horizontal—not inclined. Attached to the inside of the shell are angles which cut into, lift and pour the gravel. Chutes are threaded on the central shaft at such an angle that, as the gravel falls from the angle blades, they propel the material steadily toward the discharge end. This shaft, and the chutes on it, are stationary. The material is fed into the washer through the feed chute. Water is sprayed into the cylinder at the discharge end, through the hollow central shaft. The dirty water escapes at the opposite end. The water and the gravel flow in opposite directions, so that the clean water is first used for the final rinsing of the material, while the dirty water is employed in the first stage of the washing process. The barrel of the washer is 30 in. in diameter. It will wash 5 to 6 cu. yd. of gravel per hour. Water required, 10 to 15 gal. per minute. The minimum power to run machine is 2½ H. P. The washer is made by the Smith Engineering Works, Milwaukee, Wis.



No. 30 Telsmith Portable Gravel Washer With Screen.

THE BLACKBURN-SMITH ENCLOSED TANK SWITCH.

This switch is of the single-pole double-break type, is instantaneous in action and suitable for use with tanks, etc., wherever regulation of liquid level between high and low limits is required. This regulation is obtained by a float operating the switch, which in turn actuates a solenoid controlling mechanical or other electrical devices.

The joint of the case is flanged to permit the use of gasket when desired for waterproofing and the internal electrical and mechanical parts are separated by an inside dividing partition which forms two separate compartments. A block of transite ebony asbestos bolted into the electrical compartment of the case supports the fixed contacts and also acts as an insulating bushing for the incoming wires, which are brought through a threaded boss in the back of the case.

The fixed contacts are short cylinders of carbon held by set screws in machined brass terminals bolted to and insulated by the transite block. The moving contact is a folded copper strip bolted to a piece of transite, which is loosely pivoted in the forked end of the cam lever. A flat spring within this fork keeps the contact piece always in correct position.

The operation is as follows: As the float riding up and down on a guide rod hits a limiting stop on the rod, the rod is carried up or down, and through collars upon its upper end imparts a corresponding movement to the switch lever. Movement of the lever oscillates a shaft and "grasshopper" levers which in turn move a roller across a cam on the end of the electrical contact lever. The roller is held closely to the cam by a coil spring fastened to the dividing partition in the case. The tension

Switch with Cover Removed.

from this spring throws the contact lever with a quick, positive motion the instant the roller passes over the center of the cam.

This switch is furnished alone or with auxiliaries for mounting either on a cover or a tank wall. It has been approved by the Underwriters Laboratories and is now being manufactured and marketed by the Blackburn-Smith Corporation, 105 West 40th Street, New York.

NEW TRACTION TYPE SHOVELING MACHINE.

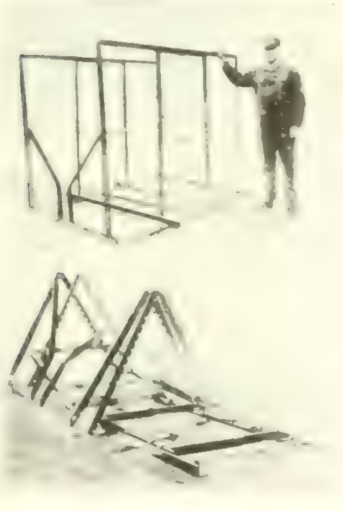
A traction type shoveling machine, designed particularly for use in loading from stock piles, is shown in the illustration. This machine consists of a cast steel frame mounted upon three wheels; the two front wheels [illegible] wheel and the rear wheel is [illegible] to

Traction Type Shoveling Machine.

steer the machine. At the forward end of the cast steel frame is mounted an adjustable yoke carrying the shovel. This is automatic in action and can, it is claimed, handle a ton of loose material per minute. This shovel is also capable of lifting pieces weighing as much as 1,000 lb. or any rock not over 28 in. in any one dimension. The shovel discharges directly onto an armored belt conveyor which delivers into a hopper supported at the rear end of the conveyor frame. This hopper is designed to hold one buggy load or car load and in the operation of the machine this hopper is kept filled by the operator, and it is arranged to discharge instantly into the wagons or carts used to carry the material away from the machine. The machines can be equipped with any standard type electric motor or with gasoline or air engine. The total weight of the machine, including motor, is about 13,500 lb. It is especially adapted to handling stock piles of coarse or fine material, loading same into carts or trucks which run upon the gound. The machine is manufactued by the Myers-Whaley Co., Knoxville, Tenn.

COLLAPSIBLE FORM FOR 4 TO 5 FT. CULVERTS.

A 1-man collapsible culvert form that can be used for constructing culverts from 4 ft. to 5 ft. in height and from 6 ft. to 8 ft. in width has been added to the line of the Storms Manufacturing Co., Crawfordsville, Ind. The form operates on the same principle as the smaller size forms of this concern. With this form it is claimed that a saving of 25 to 50 per cent can be made in culvert construction. In the illustration the top view shows the form assembled ready for the wood frames. The bottom view shows the forms collapsed. These forms are tripped by pulling on the cross rod, which causes the frame to collapse and gives the necessary clearance for the removal of the casing lumber. After the lumber has been withdrawn, a pull at the center bar of the form draws in the side sills, giving ample clearance for pulling out the forms. The collapsing and removal of the forms including the lumber, in several recent jobs, has been accomplished by one man in less than 5 minutes' time. The forms can be used for molding either the arch type culvert or the box type. They are made in three sizes: No. 1 for culverts from 14 by 16 in. to 22 by 28 in. inside dimensions and lengths from 4 ft. to 30 ft.; No. 2 size for culverts with inside dimensions from 24 by 26 in. to 30 by 40 in. and lengths from 4 ft. to 30 ft., and the No. 3, the latest for culverts 4 to 5 ft. in height. These figures are based on the use of 2 in. lumber for casing.



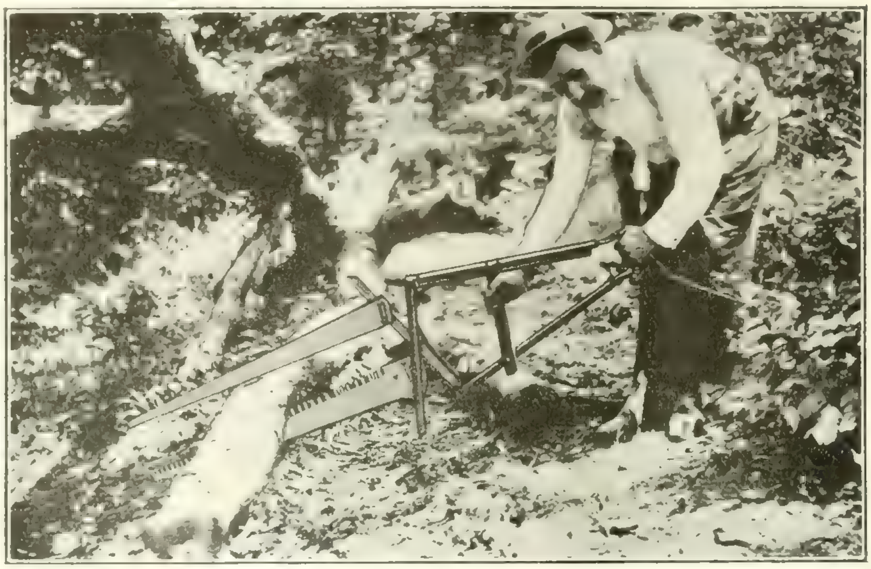
Upper—Form Assembled. Lower—Form Collapsed.

ONE MAN SAW DOES WORK OF TWO MEN WITH CROSS CUT SAW.

A one man saw that is stated to do as much work as can be accomplished by two men with a standard cross cut saw should prove of interest to contractors. It could be used for cutting square timber, and tunnel props, cutting poles, etc., etc. A saw of this kind has recently been placed on the market by the International Saw Co., 625 North 3rd St., Newark, N. J. Comparative tests of this saw with a 2-man cross cut saw made last April gave the following results:

	Cross-cut two men No. of strokes.	Machine saw one man No. of strokes.
11-in. chestnut log	92	70
9-in. yellow poplar log	44	30
9-in. white oak	109	96

The saw consists of two steel arms actuated by a powerful connecting spring and crossing at the other end through a slide. Brackets are fastened to each of the flat ends, to which the blades or plain pressure bars are attached. Two blades can be used or one blade and one pressure bar, the former cutting the more rapidly. When starting the two blades (or blade and plain pressure bar) are spread against the resistance of the spring and straddle the tree. The saw is simply worked forward and backward, all the necessary pressure being furnished by the spring whose tension is balanced by the compensating spring action through the hollow bar attached to one arm. The entire machine weighs 12 lb.



Ordinarily the Cutting Blade Is On Top of the Log, but When Circumstances Require, the Saw Can Be Placed Below the Log, the Pressure Bar Being Above.

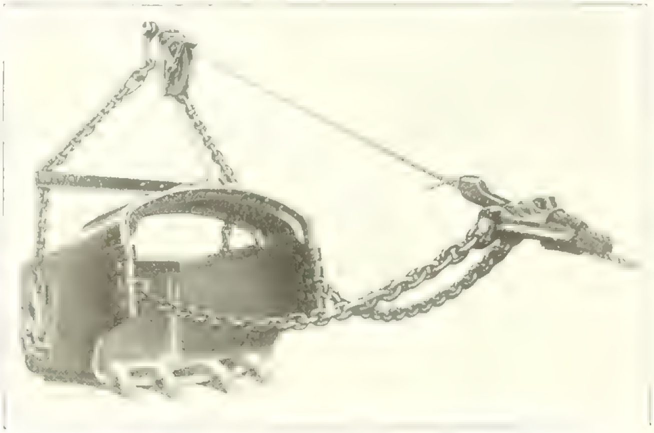
A TRENCH MACHINE THAT DIGS AND BACKFILLS.

A machine, which it is claimed will dig and backfill any ordinary trench and requires only two men for operation, has been brought out recently. The digging is done by a movable steam shovel operated by an engine placed on a stationary car ahead of the trench to be dug. The shovel itself is mounted on a light, quick-acting, separate car, which is built to pass over sheeting to a height of about 8 ft. above the surface. A movable anchor is placed at the opposite end of the trench. The dipper car is moved by the same lines that do the holding and digging back and forth upon the trench. With an operating crew of but two men—an engineer to run the engine and a car operator—the earth is dug ahead by the dipper, carried back, and dumped into the trench again. If for any reason the dipper cannot be operated, it is locked up out of the way upon the car, and by means of an additional fall block, buckets can be lowered into the trench, filled by hand, and then hoisted and backfilled. In addition to the digging and conveying the machine can be used for handling boulders, pulling sheeting planks, shifting pumps, loading wagons, etc. The complete machine can be loaded on one flat car, and it is stated that it can be assembled in two days after arrival at the work. This trench digger is manufactured by the Moore Trench Machine Co., Rockaway, N. J.

Front End of Dipper Carrying Car.

NEW PULLING BAIL CONNECTION FOR SCRAPER BUCKETS.

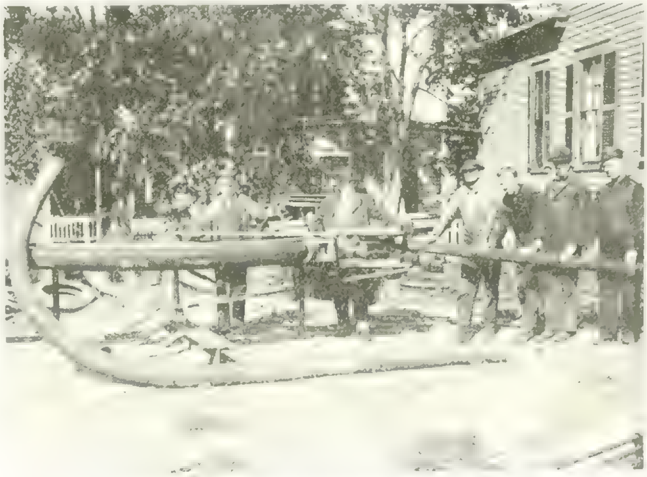
Patents have been applied for by Mr. John W. Page of the Page Engineering Co., Chicago, for a new pulling bail connection for scraper buckets. The fastening consists of a plate clevis fastened to each cheek plate of the bucket, the pin of this plate clevis being vertical and the plate clevis being arranged to accommodate the small connecting clevis in two or more positions. In this design it is claimed that all of the wear comes on the pin of the plate clevis which is easily replaced, and even if the plate clevis itself becomes worn, as it will undoubtedly in time, it can be replaced in an ordinary blacksmith shop. Another advantage claimed for this new connection, is that it virtually increases the hood or over-hang of the scraper bucket beyond the cutting edge. This is very important as the digging tendency of the scraper bucket largely depends on the over-hang of the point of attachment of the pulling chain beyond the cutting edge. A third advantage is that the connection has very little width, thus offering little resistance when the bucket is being loaded. It is stated that the connection when placed on the standard bucket of today, increases its digging ability or when used in designing new buckets, the hood or arch can be shortened where this connection is used. All Page buckets, except those of the very heaviest type, are at present being fitted with this connection.



New Pulling Bail Connections for Scraper Buckets.

BENDING MACHINE MAKES 90° COLD BEND IN 6 IN. PIPE.

A machine capable of making a 90° cold bend in a 6 in. iron pipe in less than 10 minutes has been brought out recently. The labor cost in making a bend of this kind with the machine is about $1.50. The bender is manually operated. It consists of a semicircular head, which is supported by an upright and from which arms extend to carry the bending shoe and a toggle-jointed lever. The pipe is placed behind the head and the bending shoe and pressure applied by moving the lever. In making the 6 in. bend, six laborers handled the lever. This machine is made in five sizes for bending pipe from ⅛ in. to 6 in. in diameter. The largest size, Model C Wonder Pipe Bender, is shown in the illustration. This particular model is made for bending either iron or steel pipe from 4 in. to 6 in. in size. The machines are manufactured by the American Pipe Bending Machine Co., 37 Pearl St., Boston, Mass.



90 Bend in 6-in. Pipe Shown in Foreground Machine That Made It in Background

NEW PAVING GUARD FOR PROTECTING EDGES OF PAVEMENT.

A paving guard that reinforces a roadway at its weak points, the edges, and [illegible] the wearing surface at the same time preventing water seeping into the surface, has been placed on the market re-

Guard in Place.

cently by the International Steel Tie Co., Cleveland, O. The guard is indicated by the accompanying sketch, consists of a steel angle held in place by anchors buried in the concrete base. The method of installation also is shown in the sketch. The guards are made in various sizes: 2 in. for asphalt; 3 in. for street railway paving and headers; 4½ in. for brick pavement. The company also manufactures grooved guards for street railway paving.

STANDARDIZED DUMP BODY UNDERFRAME REDUCES MOUNTING COST.

By means of the quadruple adjustability of the underframe structure of a steel dump body for motor trucks, illustrated in accompanying detail drawings, it is claimed that any one owning a motor truck requiring a new dump body may purchase the body unit complete, with all sills, fittings and fasteners and mount it on any chassis frame with ordinary tools, without drilling holes or driving rivets. The longitudinal sills are adjusted by means of malleable casting brackets and a slot opening in "I" beam transoms (Section "BB," Fig. 1). The hinge casting and rod on which body pivots when dumping (Sec. "AA," Fig. 1) are also adjustable by means of a "turn-

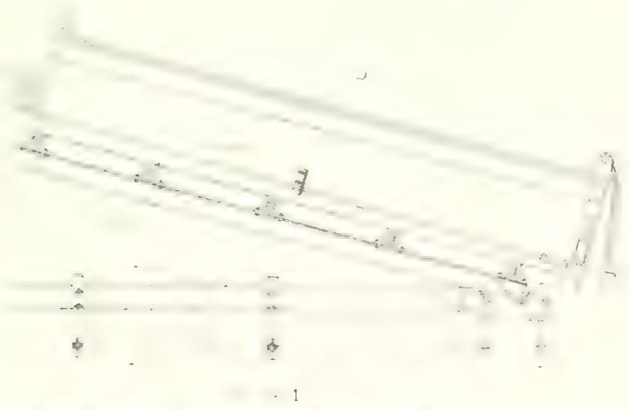
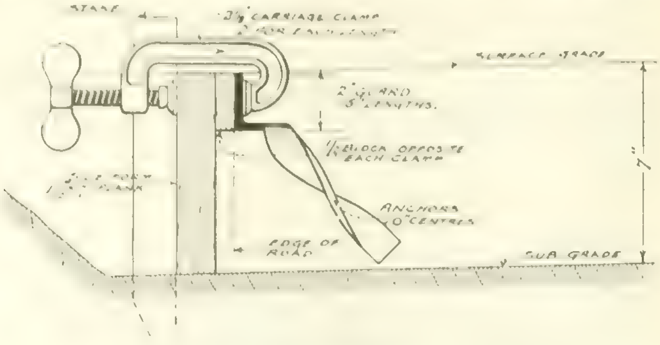


Fig. 1—K. & J. Standard Steel End Dumping Body.

nut" in center and "castle-nuts" on each end of rod. The bolting arrangement which clamps sills and hinge castings onto frame is also adjustable to fit around any size of chassis frame. This eliminates drilling holes in frame, which often causes "frame fractures." The design also allows the use of a 6-in. seasoned oak sill to absorb "load shocks," without raising load higher than necessary to give proper clearance at wheels. Three holes are provided in "hinge casting" (Fig. 1) to shift body forward or backward for proper attachment to hoisting mechanism. A "partial dumping" tailgate (ratchet control) is also provided, permitting op-



Method of Installation

erator to "spread" materials with truck in motion. These bodies also "nest" or fit one within the other for shipping, hauling and storage. This adjustable underframe structure was invented by B. D. DeWeese, manager of the Motor Truck Body Sales Department of

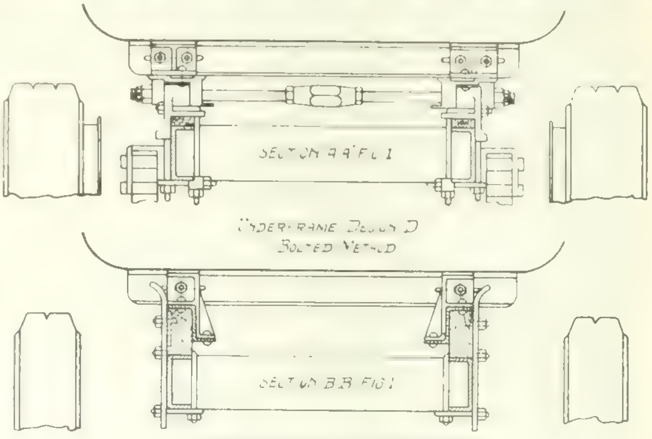
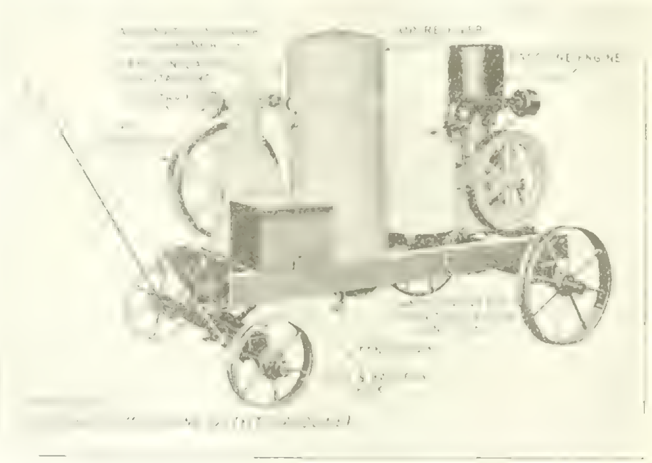


Fig. 2—Sections of Underframe.

the Kilbourne & Jacobs Manufacturing Co., of Columbus, O.

EQUIPMENT FOR PAINTING WITH COMPRESSED AIR.

Portable equipment for applying paint by the spray method is illustrated. The essential features of the



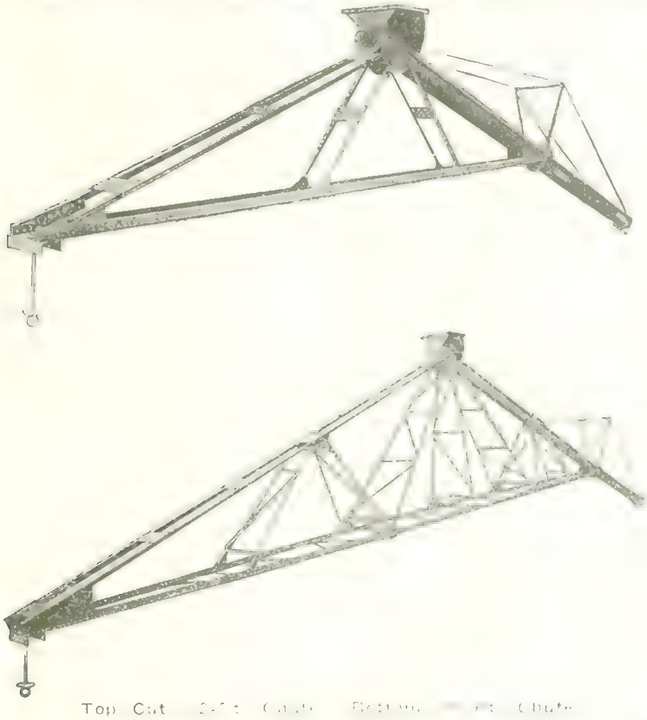
Portable Compressor Outfit.

outfit are indicated in the illustrations. The operating method is as follows: The paint tank regulating head inlet is connected with ½-in. air hose to the compressing outfit outlet. One or two spray heads are connected with ⅜-in. air and ½-in. fluid hose to the regulating head outlets. The paint is put into the tank through filter plug hole. After screwing in plug, starting compressor, and opening valves, the air pressure on the paint in the tank and the air pressure used at the nozzle of the spray head are regulated to meet the varying conditions of size of nozzle, weight and viscosity of paint, height of nozzle above tank and nature of surface to be painted. The air pressure on the paint should not be more than necessary to raise the paint to and cause it to flow slowly from the nozzle held in a working position. The air pressure at the nozzle should be just sufficient to atomize the paint. The nozzle is held about 6 to 10 in. from the surface and moved back and forth with smooth, even strokes. This equipment is made by the De Vilbiss Mfg. Co., Toledo, O.

Portable Paint Tank.

COUNTERWEIGHT CHUTES FOR CONCRETING.

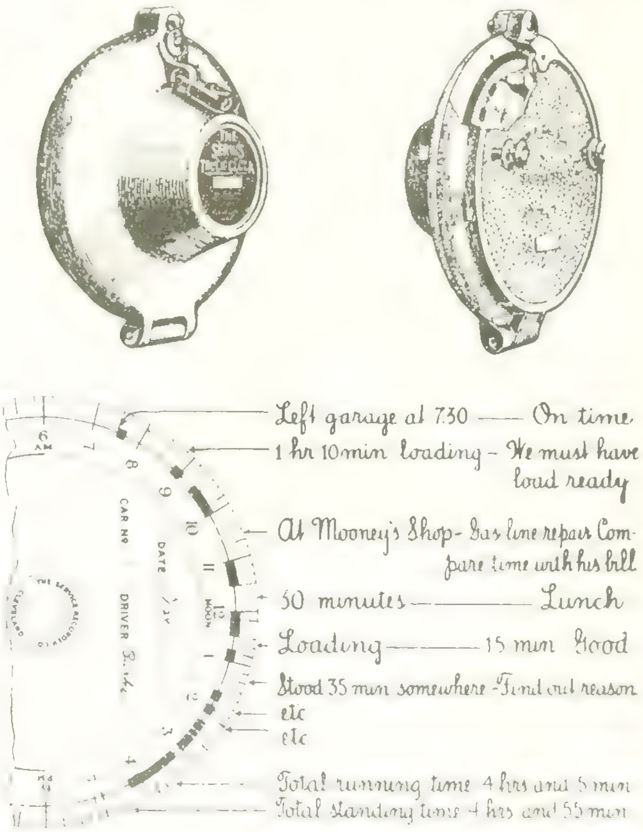
The most recent and most important addition to the line of concrete equipment manufactured by the Ransome Concrete Machinery Co., of Dunellen, N. J., is their counterweight chutes. The big feature of these chutes is the hog-rod trussing of the last section and the fact that the 32-ft. swivel is built strong enough to carry a 32-ft. swivel head section while the 48-ft. counterweight chute is proportionately strong enough to carry a 48-ft. swivel head trussed section at its lower end. The main part of the new counterweight chutes [illegible] of high carbon steel the same as the standard Ransome chutes. This superior strength and hardness insures much greater resistance to abrasion and longer wearing qualities. Besides this the cross section of the new design has been increased 50 per cent in area, another element of strength and endurance.



Top Cut, 32-ft. Chute; Bottom, 48-ft. Chute.

TIME RECORDING DEVICE FOR MOTOR TRUCKS.

An instrument for indicating all movements of power trucks was placed on the market last season by the Service Recorder Co., Cleveland, O. This device, known as the Servis Recorder, shows the time of starting the truck and each stop, the duration of the stop and when start was again made, so that the record is complete so far as movement of the truck is concerned.


6 AM
7
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1
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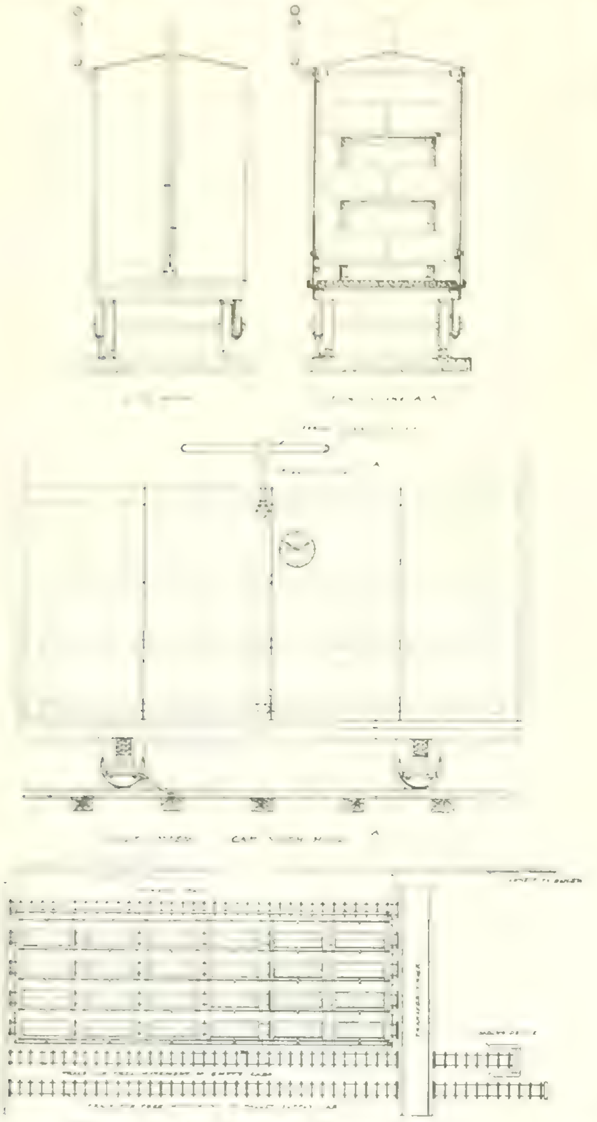
4
CAR No
DATE
DRIVER
THE SERVICE RECORDER CLEVELAND
Left garage at 7.30 —— On time
1 hr 10 min loading - We must have load ready
At Mooney's Shop - Gas line repair Compare time with his bill
30 minutes —— Lunch
Loading —— 15 min Good
Stood 35 min somewhere - Find out reason
etc
etc
Total running time 4 hrs and 5 min
Total standing time 4 hrs and 55 min

Instrument for Recording Truck Movements and Section of Chart.

The instrument consists essentially of a specially constructed clock movement that is, with a marker or indicator and a chart, entirely enclosed in a heavy metal case. There is no outside connection, but the device may be bolted to the truck chassis or body in any one of a dozen convenient places, and, in fact, it would indicate if it were merely carried aboard the truck. In operation it is actuated by the side sway, which is always created when any vehicle is in motion. The side sway causes a pendulum to oscillate and the pendulum is fitted with a steel stylus or marker which marks a travel path on a waxed chart that revolves once every

SPECIAL CARS FOR STEAM CURING CONCRETE PRODUCTS.

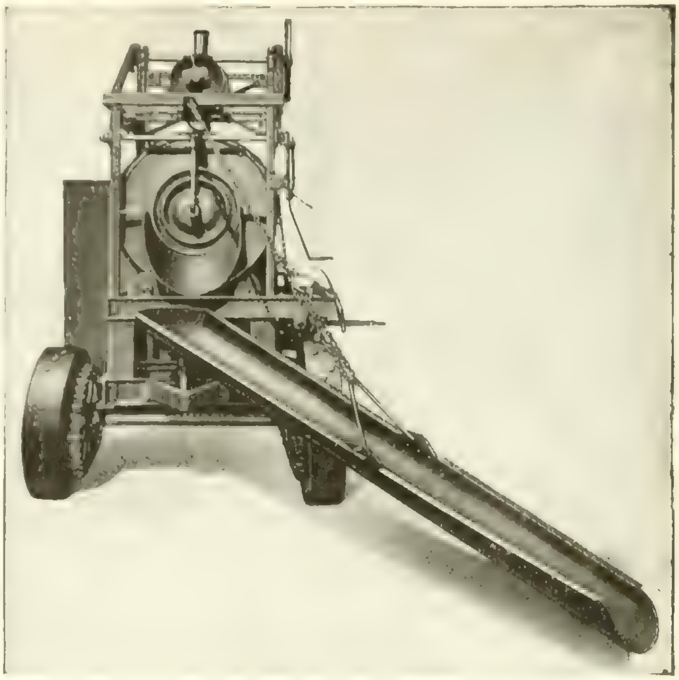
Curing cars by means of which concrete products may be subjected to steam treatment immediately after manufacture and the treatment continued without the interruption of opening curing room doors have been developed by the Brandell Co., Cincinnati, O. It is claimed that with this equipment the steam curing period may be reduced to about 8 hours. Details of the car are shown in the accompanying drawing. Each car is a steam curing chamber. When filled the car is moved to a storage space, covered by a metal hood, and the steam turned on through a flexible coupling, the supply being obtained from an overhead line. The hood is air tight. It is made of a heavy gage galvanized iron and is lowered and raised by a pulley arrangement. This system of curing proposes the elimination of separate steam curing chambers or tunnels. It also is claimed to save a considerable amount of steam as there is very little waste space around the cars.



Steam Curing Car and Track Layout.

RANSOME 7-E HIGH-DRUM PAVER.

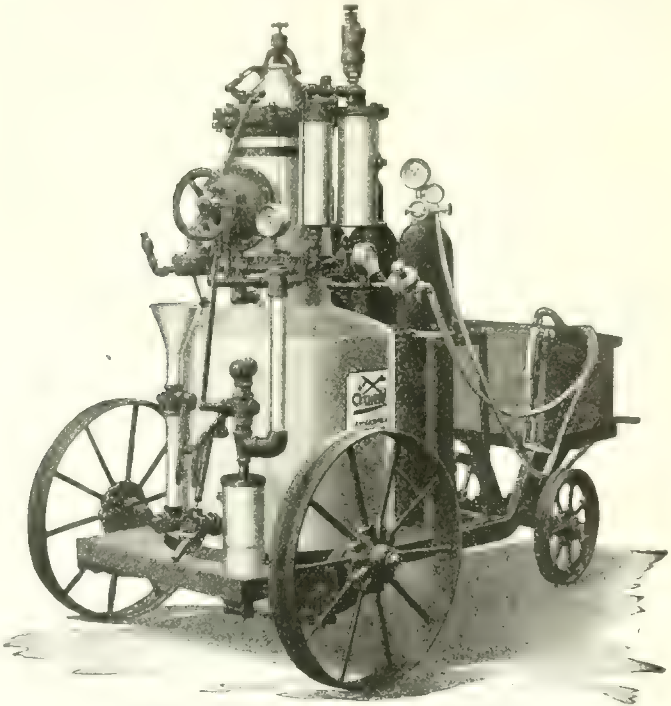
A mixer particularly designed for handling small paving jobs such as alleys, long driveways and narrow roads, is illustrated below. This is the Ransome 7-E high-drum paver. It is a natural development of the [illegible] batch Bantam mixer. The paver is equipped with open-end pivot hopper with dumping bar for quick dumping, also the 10-ft. distributing chute which has a clear swing of nearly half a circle. The mixer end of the chute is 4 ft. 8 in. above the ground so that a fairly steep slope (21°) can be obtained when desired. Its weight is a little over two tons.



Ransome 7-E High-Drum Paver.

NOVEL PORTABLE WELDING AND CUTTING UNIT.

A hand truck type of portable welding and cutting unit was originally designed by the Oxweld Acetylene Co., Newark, N. J., for Government war service, but its adaptability to general purposes was instantly recognized, and a demand for it has grown up, particu-



Portable Unit for Welding and Cutting.

larly among contractors. The truck contains a complete welding and cutting station, including Linde oxygen cylinder, Prest-O-Lite acetylene cylinder, regulators, hose, blowpipes, and the necessary fluxes, welding rods and other accessories. The regulators are so mounted that no time is lost in making connections with the cylinders—a good feature of every day efficiency, but invaluable when the outfit is called upon for emergency service. There is a place for everything in the apparatus chest, and hence, if any place is vacant, the negligence of an operator in not replacing his tools at once becomes conspicuous. The chest is securely locked, when not in use, by means of a padlock. The weight of the outfit complete is about 550 lb., and the truck can be easily handled by one man.

RECENT INVENTIONS IN TOOLS AND MACHINES FOR SHIP BUILDING.

The great activity in ship building in this country in the past year resulted in the development of many new methods and practices in the shipyards. Numerous machines and devices for superseding hand work were invented. The mechanical air-driven plane, alone, in the first few months after being placed in operation, released 2,000 men for other service. The following notes summarize a few of the inventions:

Mechanical Bolter Up.—In ship building thousands of temporary bolts are put in to draw up and pull the plates and bars together, before riveting. Those put in through the keel and shell at the bottom of the ship are tightened by workmen with uplifted arms. In that position it is not possible for a man to exert his full strength, because with one hand he holds the wrench on the nut, and with the other hand, he either pulls, or pushes the wrench. When doing this he must use every care to prevent injury to his hands. Very often the wrench slips off the nut and his hand foul of one or more bolts and nuts already in place. A device for mechanically doing this bolting was invented by Mr. David Martyn of the Vancouver, Wash., shipyard of the G. M. Standifer Construction Co., It consists of a steel tube about 36 in. long, fitted with a cap at its bottom end. In the tube there is a suitable valve, to which is attached a compressed air hose. Into the tube is placed a square piston rod, having a piston attached to its bottom end. At the top of this rod, sockets which fit the different size nuts may be placed. Resting on the top of the tube is a piece of steel, hexagonal in shape, which has a square hole in it, to fit the square piston rod. A lever, or wrench, having a hexagonal hole, fits over the steel piece just described. To use the machine, the workman attaches the compressed air, then opens the valve. The air forces up the piston rod and its top end, on which is the socket, is guided over the nut, onto the bolt to be tightened. The lever is turned round until the nut on the bolt is screwed up and the plates drawn together. To remove the machine the operator turns off the air. The "bolter-up" also is an air jack, for the application tends to force the plates together, before tightening the nut, and at that time. By using it the plates, or bars, are brought firmly and close together, which insures good riveting and excellent workmanship. It is estimated that by the use of this machine one man can do the work of five. The machine is made in three lengths, each having sockets to fit [illegible] and 1 in. nut

Apparatus for Bending Frames for Wooden Ships.—A new method of seating and bending the frames upon wooden ships was invented by Mr. Frederick Meron, mechanical engineer, of New York City. The wood timbers are first saturated by means of steam, preparatory to subjecting the timbers to pressure for bending them to the necessary shape. This new method obtains a uniform saturation which was not obtained under the old plan. The invention provides for continuous saturation of the timbers with low pressure or exhaust steam, so that all sides of each piece are treated uniformly. This inventor also devised apparatus for the shaping of the wood after it is steam heated, so that the parts may be turned out in quantity.

Riveting Device.—A rivet device, cutter and buffer was the invention of Engineer Rioux, a riveter at the Merrill Stevens Shipyard, Jacksonville, Fla. The set is composed of the regular riveting head, built in a new way, having at one side, and made into the head, a rivet head cutter and buffer. It is said to be impossible for vibration to shake loose the cutter, it being fastened with a safety lock, also made into the driving head. The invention has been patented, and its manufacture is being financed by E. C. Broward of the International Marine Planer Co.

Angle Saw Reduces Three Cut Operation to One.—A saw that crosscuts timber at any angle with one operation was the invention of David C. Martyn and H. P. Stacey, employes at the shipyard of the G. M. Standifer Construction Corporation, Vancouver, Wash. The saw was adopted at the Vancouver wood yard and at the North Portland yard of the Standpipe Co. It is an angle cut, cut-off saw, and different from the ordinary swing saw, which could only cross-cut a square cut or a right angle. The method used in the majority of shipyards is to cross-cut the pieces to the desired length by a swing saw, and transfer them to the band saw, where the angle is cut. With this device one cut now takes the place of three, as formerly done in other yards. The machine is described as follows: There is a platform, say, 7½ ft. square. Upon it there are two pieces of angle iron bent half round, each forming a segment of a circle. In the center there is a ball-bearing pivot; upon this pivot segmental angle irons; there are two rails 14 ft. 6 in. long which are braced together and form a turn-table. Above that is a wood frame, to which is attached suitable bearings for the saw arbor. On the top at the other end of the frame is an electric motor, which by means of a belt is connected to the saw shaft. The saw is 48 in. in diameter and the motor 20 HP., making [illegible] revolutions per minute.

Folding Square.—A folding square, which serves the triple purpose of a protractor, inclinometer and angle device, besides doing all the old duties of the steel square and the time-honored yard stick, is the invention of Joseph La Follette, an employe at the Portland, Ore., shipyard of the Foundation Co. The principal advantage which is claimed for the invention is that with it the workman can perform all sorts of work that he [illegible] unless supplemented by [illegible]

Rollers for Bending Angle on Channel Irons.—[illegible] Shipbuilding Co. [illegible] rolling mill [illegible] bend angle or channel irons. The machine adapts the rolling mill idea to the task of converting an angle iron of the right angular form into one of a different angle. A bar of iron is passed between a pair of rollers and can be bent to any acute angle or obtuse angle, by adjusting [illegible] made [illegible]

Cold Plate Bending Machine.—A cold plate bending machine that executes compound curves was perfected by S. F. Robinson, Chief Engineer of the Pensacola Shipbuilding Co., Pensacola, Fla. The machine was designed to do the work ordinarily done by the pyramid type of plate bending rolls. The frame is made of 15-in. I-beams carried on a concrete foundation. Between the beams are 14 pneumatic hoists, with 12-in. diameter pistons and 7-ft. stroke. On the top flanges of the I-beams are bolted structural steel formers with curvatures corresponding to the bends desired in the plate. The plate is placed vertically against the formers, and the bottom clamped in place against a structural steel bracket. On the head of each piston rod is a chain sheave, and around this sheave is a length of ⅞-in. coil chain. Each end of this chain is passed over a sheave carried on the outer end of the I-beam base, and a saddle casting which is laid on the edge of the plate. The ends are hooked to the base and the application of compressed air to the cylinders pulls the plate to the formers. The rear ends of the cylinders are piped for water instead of compressed air, and the length of stroke and speed of travel are governed by allowing the water to flow out through a controlling valve. An especially valuable feature of the apparatus is its ability to bend warped surfaces at one operation, as the radius of the formers at any point determines the curvature at that point.

Hydraulic Plate Tightener.—A hydraulic plate tightener, which is claimed to enable 2 men to do the work formerly requiring 20, is the invention of Archer B. Clark, of Seattle, Wash. The device is now being used in Pacific Coast shipyards. The machine is 22 in. over all and weighs 58 lb. It is portable, handled easily, and is operated by one man, assisted by a helper, working on the opposite side of the plates. The shell and piston rod of the machine are made of chrome nickel and the piston of tool steel. The triple expansion hydraulic pump is of manganese bronze. The plates to be bolted up are placed between two compensating nuts of the plate tightener, the piston rod, taking the place of a bolt used in the hand method of tightening, is slipped through the proper holes punched in either plate, the lever is worked by hand and forces oil down on the piston rod in the chamber or shell until a pressure of 20 tons is exerted in drawing the plates together. When the plates are drawn together by hand not all of the spring is ever entirely taken out of them. The plate tightener is stated to absolutely take out all spring in the plates. Once the plates are drawn together tightly, bolts are slipped through the holes on either side of the piston rod and screwed up. The machine is then moved over two holes and the process repeated. In the hand method, repeated changes in lengths of bolts have been required, considerable delay being entailed in putting on washers to take up the added space from time to time. With this machine but one length of bolt is required, a great saving in time and expensive materials thereby resulting.

New Protractor Rule.—T. I. Temple, a machine fitter at the Tacoma, Wash., shipyard of The Foundation Co., invented a protractor rule. A hinged arm on the end of the rule can be set to any angle, and the graduation on the rule itself automatically scales the degree of the angle. The instrument is very useful in taking measurements for angle iron work and is a valuable supplemental device to the regular protractor used by the anglesmith. It should be useful also in any other kind of work where measurements to ascertain exact angles are to be taken on the job.

Mask for Paint Sprayers.—A mask for operators of paint spraying machines designed to be worn whenever the operator might otherwise be forced to inhale paint laden air was invented by Gordon Phillips, foreman, and Pat Hanlon, assistant foreman of the paint department at the Ecorse shipyards of the Great Lakes Engineering Works. The mask is in use at this shipyard. It is similar to some of the earlier types of gas mask used on the Western front. Rubber tubing brings an uninterrupted supply of fresh air to the wearer. Small copper tubing, punched with holes encircling the glasses, prevents any paint from gathering there and insures perfect vision at all times. The mask proper is made of papier mache. No cap or hat is worn, so the mask fits snugly around the crown of the head and along the cheek and jawbones. A curtain of rubberized cloth falls like a mantle from the mask over the neck and shoulders of the wearer as further protection.

Power Planers.—Two, possibly more, power planes have been developed in the shipyards that are building vessels for the Emergency Fleet Corporation. One of the most popular, which is used extensively on the Western Coast, was invented by Johannes Emil Christensen, a skilled worker in the St. Helens Shipbuilding Co. yards, St. Helens, Ore. The planer weighs but 10 lb. and is only 16 in. over all. The wearing parts of the instrument are so few and so well protected that it is said not one has had to be replaced, although some have been in service 10 months. In a demonstration on the coast recently a workman with the tool planed 385 sq. ft. in five hours. Eight men working against him by hand finished 275 sq. ft. in seven hours. Two models of this particular machine are made. One of these will do outboard dubbing, joining and finishing. It will cut through treenails, knots, marine glue and pitch—leaving a clean, finished surface, and it is claimed will do work equivalent of 15 to 20 men with hand planers. This model consists of a bronze cutter head with a turbine attached to either end and hung on ball bearings in an aluminum frame. The point where the head revolves on its ball bearings is the only place where there is any friction or chance to wear. The cutter head holds two high-speed blades so attached that they can be taken out with slight troubles for sharpening. At the front of the aluminum frame is a shoe with a screw adjustment to regulate depth of cut and fit to concave and convex surfaces. The air is controlled by a valve in the handle which shuts off the power automatically when released. The other model is constructed on a different cutting principle. The knife revolves on a plane horizontal to the work, the cutting stroke of this type approaching that of the adz. One double bronze turbine operates the cutter. The turbine, with cutter attached, is hung in the frame on ball bearings. Adjustment of the "bite" to desired depth is instantaneous by means of a lever on a quadrant which shows depth. Good air pressure is necessary to get best results with the tool and it is recommended that the gage show not less than 80 lb. of air.

Road and Street Monthly Issue

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Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power

Railways and Govt. Works—3rd Wednesday
(a) Excavation and Dredging
(b) Rivers and Canals
(c) Harbors and Docks
(d) Railway Construction

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Ship Construction
(d) Miscellaneous Structures

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Objections to the Proposed Increase in Freight Rates on Road Materials

The public pays for road construction and the public must also pay for the deficit in railway net earnings as long as the Government operates the railways. In order to reduce this deficit the Railroad Administration is considering a plan to raise freight rates on sand, gravel, stone, slag and cement—the principal road building materials. If the plan is adopted, the deficit in railway earnings will be somewhat decreased, but the cost of highways will be correspondingly increased. The Railroad Administration will make a better showing as to earnings, but at the expense of a poorer showing by highway officials as to the cost of building and maintaining roads and streets.

This furnishes an excellent example of how one department of Government often seeks to gain at the expense of other departments of government, unless action is taken by some third department of government to secure general economy and equity. In this case the Interstate Commerce Commission and the State Railroad Commissioners should be the "third department" to settle the rival claims as to equity; but as long as the Railroad Administration retains its extraordinary rate fixing powers, highway commissions and city officials will be almost helpless. It is certainly high time that the Railroad Administration's rate fixing powers be restricted.

If Congress wishes to aid the great roadbuilding program, it should lose no time in depriving the Railroad Administration of the power to establish freight rates.

The proposed increase in freight rates on sand, gravel, [illegible] per cent and this is on top of a recent [illegible] per cent increase. Never was a more short-sighted act proposed than to increase the cost of highway materials by raising freight rates.

Under "private management" of railways, the railway companies often gave exceptionally low freight rates on road building materials. They realized that not only was it good public policy to do so, but that any general improvement in the condition of the highways would result in greater railway earnings.

A short-sighted railway policy would treat the highways as competitors of the railways, but such a policy has rarely existed in any railway company. Not only does the building of better roads increase the amount of farm produce shipped by rail, because of the greater prosperity of the farmers who have good roads, but the existence of "all the year roads" greatly reduces railway congestion by enabling farmers to deliver their produce to the railways more uniformly. In the absence of hard roads, farmers rush most of their grain crops to market in the early fall to avoid the mud that comes as soon as the fall rains start. Hence every autumn there is a "crop moving congestion" and car shortage that would be largely reduced were hard roads generally available in the grain raising states.

Put in another way, the "peak load" on the railways can be greatly reduced, and railway expenses correspondingly brought down, by the construction of an adequate system of "all the year roads" in the farming states. Just as Illinois, Michigan, Ohio, Indiana, Iowa and other great farming states are beginning to plan the expenditure of large sums for state highways, the Railroad Administration throws cold water on these projects by proposing to add greatly to the already high cost of road work. In our judgment it would be good public policy to cut in two the present freight rates on road building materials. We believe that nearly every student of transportation economics will agree with us in this matter.

Elsewhere in this issue we quote some of the protests against raising freight rates on road material.

Why the Texas Highway and Railroad Commissions Should Not Be Consolidated

A bill has been presented to the Texas legislature to consolidate the highway commission and the railroad commission, and thereby bring under one corps of engineers, [illegible] the work of both commissions. It is evident that the sponsors for this bill do not appreciate that a corps of engineers thoroughly competent to conduct appraisals of public utilities and railways would not be competent to design and build highways, and vice versa. The average layman, knowing little of the specialization necessary in modern engineering practice, is apt to think that a civil engineer can turn his hand to any class of civil engineering with equal facility. Doctors treat all kinds of disease, and lawyers take all kinds of cases, then why shouldn't any civil engineer be competent to design and direct any kind of engineering work?

It is true that there are engineers who have a general engineering practice that is very diversified, but they either employ a corps of specialists or they operate individually on a small scale in small communities. In the latter case they usually employ consulting engineering specialistis when they secure important jobs. Obviously a great state like Texas can not afford to employ engineers that are not specialists. The road problems in Texas are as varied and as important as in any state in the Union. Texas is just about to begin the construction of state roads. Surveys and plans for 1,772 miles, to cost $7,253,000, have been made. The engineering salaries for this work have totaled only $35,866, or less than half of one per cent or about $20 per mile of road. This is a very low cost, an extremely low cost, for work of this character.

A creditable beginning has been made by the Texas Highway Commission, whose chairman is Curtis Hancock. We doubt not that if the legislature will give the commission two years in which to show construction results, all talk of abolishing the commission will cease forever.

Is the Constitution of Your State as Archaic as That of Minnesota?

A year ago how many civil engineers or contractors in the state of Minnesota knew that the state constitution limited state tax levies for roads and bridges to one mill on the assessed valuation of the state? This absurd limitation makes it impossible to raise more than about $1,600,000 during 1919 for state-aid roadwork. Hence unless the constitution is speedily amended, Minnesota with its $4,108,000 share of the Federal appropriation for road work for the state, must match dollar for dollar with the Federal Government.

But this is not all. The constitution of Minnesota prohibits the state from incurring any debt whatsoever for works of internal improvement! Consider the economic absurdity of such a constitution, and then ask yourself whether your own state constitution may not be equally absurd in some of its provisions that restrict public works.

As noted in our Jan. 1 issue, the engineers of Minnesota are taking steps to secure a revision of the state constitution. Engineering societies in other states should lose no time in studying state laws and constitutions as well as city charters, with a view to securing amendments that will facilitate and encourage liberal expenditures for public works.

The Prospective Loss in Municipal Revenue When John Barleycorn Dies

One of the arguments against prohibition has been the prospective loss of municipal revenue from taxes on the liquor traffic. The argument is somewhat plausible until statistics are applied to it. Then it is clearly seen to be sophistical.

According to the Bureau of the Census there were 219 cities in 1917 having a population of 30,000 or more, and their aggregate population was 33,257,431. In round numbers the total revenue that these cities received in 1917 was $1,065,000,000, of which $37,000,000, or only 3.5 per cent, came from taxes on the liquor traffic. In other words, the total per capita tax of these 219 cities was about $32, of which only $1.40 came from liquor taxation.

Evidently it would be no great burden were the public to tax itself $1.40 per capita to make good the decrease in city revenue that will occur when all saloons are closed. Probably, however, the tax will simply be shifted to the soft drink emporiums and sweet shops; and we doubt not they would gladly bear the new burden rather than lose the new business that will flow to them after John Barleycorn's wake.

Public Work Should Go Ahead Regardless of Prices

Three months after the ending of the war finds America still hesitating as to what should be done to restore the country to normal business conditions. President Wilson sailed for Europe, saying that our industries needed no governmental assistance or guidance and that readjustment was occurring rapidly and automatically. He will return in a few days to find that industry has been halting and that the number of men out of jobs has grown steadily greater.

Fortunately the situation is becoming acute so rapidly that local and national legislators are becoming aroused. The City Council of Chicago listened the other day to several spirited and well-put speeches as to the necessity of providing large appropriations for public works. Mr. H. H. Merrick, president of the Association of Commerce, said: "You can't let the soldiers sell shoe laces, beg on the streets, or stay in the camps for lack of a job."

"It is unspeakable that the men who have offered to make the supreme sacrifice should return home to find no employment," Louis T. Jamme, chairman of the civic industrial committee, declared.

"Let us not kid ourselves. You will provide public works or public charity," Prof. Harold G. Moulton, University of Chicago, said.

"There's nothing doing on giving the boys a doughnut, a cup of coffee, and slap on the back. They merit something more substantial. They have to have work," Simon O'Donnell of the building trades union declared.

"If you don't do something willingly you will be forced to do it. There's no shirking this duty. The men will have their right to honest work," Charles H. Wacker, head of the Chicago plan commission, said.

Mr. Merrick said:

"Gen. March, chief of staff, has assured us that the army will be brought back at the rate of 300,000 a month. Within the next month he proposes to turn 785,000 out of the cantonments in this country, so that within one month we will have 1,085,000 men turned out among us, and we have not done a thing to provide for them. This is the richest country in the world. Canada at the north gives each soldier $100 and a section of land. Great Britain pays the soldier a salary for six months. We are not even prepared to give jobs to our soldiers.

"Public work should go ahead regardless of prices. We should get together. We owe a duty to the men returning.

"During the war we worked together. You will not stand for the red flag. No one should stand for bolshevikism now. The man who does should be shot, and I'm willing to serve in the firing squad. You can't stand for inadequate employment.

"Send a delegation to Washington. Get the Government to loosen up on the railroad expenditures. Send another delegation to Springfield. We must get results."

Civil engineers should note particularly the economic reasons why "public work should go ahead regardless of prices." By holding back it will be possible to secure lower prices, but only as a result of general unemployment. The cost of such unemployment will be far greater to society than the saving affected through waiting for lower prices. Civil engineers employed by the public should regard themselves as political economists, and should therefore take a broad view of the economics of public works expenditures.

City Managers' Association Takes Three Important Steps

The City Managers' Association has just taken three important steps: First, its secretary, Harrison Gray Otis, will hereafter devote his entire time to the association and to the promotion of the city manager plan. Second, a City Manager Bulletin is to be published and sent to all association members. Third, the by-laws have been so altered as to provide for an associate membership open to all friends of municipal progress, the dues being $5 a year.

This last innovation is one that Engineering and Contracting suggested editorially a few months ago, in the belief that many civil engineers will eventually affiliate with this association. City engineers, for example, should be particularly interested in spreading the doctrine that municipalities should be managed by trained men. Moreover, many a city engineer will become a city manager, and the association will be helpful to all worthy aspirants for managerial positions.

Mr. Harrison Gray Otis, who has been the able city manager of Auburn, Me., has resigned his position in order to give his entire attention to the affairs of the association and to publicity work in behalf of the city manager plan of municipal government. Mr. Otis will be one of the staff of the American City Bureau, some of whose activities are outlined in another column under the title "To Promote City Manager Plan."

Public Works or Public Charity?

The above is the title of a 20-page pamphlet by Prof. Harold G. Moulton, published by the Union League Club of Chicago. In another column we give some abstracts from this pamphlet. It deserves a wide circulation. Engineering societies and clubs will perform a real public service by purchasing and distributing copies of the pamphlet among city councilmen, village trustees, county commissioners and state legislators. Copies can be secured from the Union League Club at the rate of 1 ct. each on orders for 1,000 copies, or 2 ct. each on orders for 100 copies.

Harold G. Moulton, who has a national reputation as an economist, is the author of a notable series of pamphlets dealing with the business situation in war time. These were published and given wide distribution by the Union League Club of Chicago and proved helpful in the speedy adjustment of business to war conditions. Prof. Moulton is a member of the Department of Political Economy of the University of Chicago; acting editor of the Journal of Political Economy; secretary of the Western Economic Society; author of Industrial Conscription; Some Dangers of Price Control; Unusual Business, Not Business as Usual; Your Business and War Business, the Duty of the Consumer in War Time, etc.

Prof. Moulton estimates that during the next 12 months five or six millions of workers will be out of jobs and seeking employment. Three or four millions will be discharged munition workers.

Owing to the poor financial condition of the railway and public utility companies, coupled with abnormally high prices of materials, Prof. Moulton predicts that those companies will not engage extensively in construction work this year. Hence he concludes that, "If we are to provide buffer employment for returning soldiers, it must be on distinctly Government projects." He says:

"In the various states of the Union there are many public works which have been postponed because of the shortage of material during the war. These should now be completed at once. The public highways of this country are recognized to be at once a disgrace to American enterprise and economically wasteful to the extent of millions of dollars annually. The case is perfectly clear, therefore, that the states should, wherever possible, put through extensive road building programs. Not only is the social value of such improvements beyond question; but the amount of employment given to labor is larger in proportion to the total expenditure than in most other types of public works.

"In passing, it may be noted, however, that many states have reached the limit of their bond issuing capacity and that some are not permitted to borrow at all. This is a result of the experience through which we passed in the decade of the thirties. With high hopes of great financial returns, the young middle western and southern states of those days engaged extensively in the construction of public highways, railroads, and waterways. They built beyond the needs of the time, however, and the disastrous years following the panic of 1837 carried the sparsely settled commonwealths of that day into bankruptcy. The reaction proved so strong that the amendments of the state constitution that resulted in the forties in many cases imposed limitations upon the borrowing powers of the state so serious that now, although the conditions which existed in earlier days have passed forever, many states are still debarred from engaging in public enterprises. True, the constitutions may be amended. But the time required for such drastic procedure is so great that it could often not be accomplished until years after the transitional crisis had come upon us. There is one state, at least, where it takes six years to amend the constitution. But whether or no such states can accomplish anything in the present crisis, it is high time that steps be taken to remove the financial restrictions, which now prevent constructive internal development."

We have frequently called the attention of our readers to archaic laws and city charters that unreasonably restrict bond issues for public works. Prof. Moulton emphasizes this economic evil. It is an evil that engineering societies can be instrumental in eliminating, and now, if ever, is the time for them to act.

The Need for Engineers in Public Life

To the Editor: Much of our trouble in trying to do things and in having so much unnecessary wastage is caused by the fact that so many men are put into public office, whether national, state, county or municipal, by political appointment or election, who have at the utmost but a legal training or in many cases are but ex-stenographers. Many of them are men who never employed anybody whom they had to pay for his work out of their own pocket and they can therefore never judge the value of any man's work. Furthermore, much time is wasted by the engineer to explain to his superior officials the whys and wherefores of his work so the superior official can talk somewhat intelligently about the work performed under his direction.

A good illustration of this occurred during the first year on the Isthmus of Panama, while getting things in shape and making the place healthy. Whenever a division engineer would be absent the place of acting division engineer would be taken, not by the next ranking engineer, but by his stenographer or chief clerk, who had perhaps never seen any other machine, outside of a typewriter, and some of the most beautiful orders were sent to the engineers and surveying crews struggling in the jungle to accomplish something. Chief Engineer Stevens' great success in getting things finally properly started and in shape, so that the army engineers could finish it, was derived from the fact realized by him and as he himself expressed it, that the canal had to be dug by engineers and not by typewriters.

I [illegible] a board of engineers [illegible] than it is done today, [illegible] and the judge [illegible] the engineering experts [illegible]. Again if it is a question affecting [illegible] engineering matters before railroad or public utility commissions [illegible].

[illegible] is the almost invariable appointment by judges of lawyers for receiverships regardless of the lawyers' qualifications to [illegible]. If engineering questions are involved and the lawyer-receiver is wise, he hires an engineer to tell him what to do; then why saddle the expense of the lawyer-receiver at all on the suffering company, and why not make the engineer the receiver in the first place?

All of the above may sound as an indictment of lawyers [illegible]. Lawyers themselves will be better off when engineers take a greater part in public life and become members of the law making bodies. It would not be necessary then to hold endless congressional hearings whenever an engineering question is presented to Congress, and have engineers spend time and money explaining to Congress what is needed and wanted and usually without a beneficial result, because when the bill is finally drawn by Congress the engineer has gone again and the verbiage put into the bill often causes more harm than good.

At present our Congress consists principally of lawyers, and in many cases after having passed a law they themselves do not know what it means and very often no one else does until the U. S. Supreme Court declares what Congress must have meant. I believe no other country in the world has as many lawyers as ours and consequently we have more laws made by lawyers and, of course, lawyer-judges to define them and very often lawyer-executives to enforce them. It seems to me such an unnecessary waste of time to spend in so much talking and arguing, which could be spent for a better purpose in real construction work. How much better for our country it would be if so many bright and brainy lawyers had studied engineering in their youth and had become builders of improvements benefiting mankind instead of mere orators talking about them, but not knowing how to secure them.

New York, N. Y. PETROLUS

American Road Builders' Convention.—The 9th American Good Roads Congress and the [illegible] annual convention of the American Road Builders' Association will be held at the Hotel McAlpin, Broadway and 34th street, New York City, [illegible]. The eight sessions of the congress will be devoted to the consideration of highway transportation and the administration, financing, construction and maintenance of national, state, county and municipal highways. Papers by prominent highway authorities and reports on live topics by several committees will be presented for discussion. The general plan contemplates devoting Feb. 25 and 26 to the presentation and discussion of papers and Feb. 27 and 28 for the consideration of reports to be submitted by several committees. The business session of the Association will be held on the afternoon of Feb. 28 and the annual banquet on the evening of the 26th or 27th.

National Highway Association Formed.—Delegates from thirty-seven good roads associations, each of which has a trail of more than 500 miles, touching at least three States, held a conference at Kansas City, Mo., Jan. 21, and perfected a permanent organization, choosing "The Associated Highways of America" as the official title. Forty-eight bodies, representing all States but Massachusetts, had delegates present, but only 37 could meet the qualifications at this time for membership. An executive board of directors to be composed of the president and secretary of each of the thirty-five organizations also was decided on. General officers elected were: President, C. F. Adams, Chillicothe, Mo., president of the Pikes Peak Ocean to Ocean Highway; secretary, Frank A. Davis, Kansas City, secretary of the National Old Trails Association; treasurer, A. L. Hutchings, Kansas City, president of the Kansas City Auto Club.

The Wisconsin System of Marking Trunk Highways*

By ARTHUR R. HIRST,

State Highway Engineer of Wisconsin.

The marking and signing of a state highway system is a problem in itself, and to this problem we have devoted a great deal of attention. Our state trunk highway law provided that each state trunk highway should receive a number, which should be displayed along the road itself in a standard design, similar on all state trunk highways except the number. These highways are numbered in order of their length in miles, from 10 upward, the longest (456 miles) being number 10. The idea in selecting 10 as the lowest number was that every highway number should contain two digits, and thus give uniformity.

Standard Marker for State Trunk System.—After considering a large number of designs for the standard marker it was decided to use a triangle containing at the top the words "State Trunk Highway," then the number in large figures, and in the lower point of the triangle the word "Wis." The triangle is 10 in. wide at the top and 13 in. long and is placed on telephone poles on a white-lead and oil-paint background 18 in. wide; the triangle and the lettering being coach black. We find that it is advisable to be rather profuse with these road markers. There should be one or two on each side of intersections with other roads, and an occasional one between intersecting roads. The traveler welcomes their kindly reminder that he is still on the right road, especially at night, even when they are not absolutely essential for guidance. The white bands are just as valuable as the marker itself in outlining the route. Where a turn should be made the white band is widened to 30 in. and an "R" or an "L" stenciled beneath the marker in the white field. These markers were placed upon the telephone and telegraph poles, fences, culvert end walls, and in some cases on boards nailed to trees, where other objects were not available.

By the co-operation of the 71 counties, the whole system was marked in one week. Each county did the marking within its limits, the stencils and instructions being furnished by the State Highway Commission. As a matter of interest, 1 gal. of good, thick, white-lead and oil paint covered about 60 average poles, two coats, the bands being 18 in. wide. The cost of marking in the counties varied with the care taken, the complexity of the roads, the length in the cities, etc.; the highest county rate per mile was $5.25; the lowest $1. The total cost of marking the 5,300 miles was about $9,000, or at the rate of $1.70 per mile.

The marking covers 5,300 miles, although only 5,000 miles are on the system and maintained. This is due to duplicate marking where two trunk highways follow the same road for a distance, and to the fact that the marking continues through all cities, although streets, in fully built-up districts, of places larger than 2,500 population are not a part of the system and are not state-maintained. Careful and full marking through cities and villages is very essential and can hardly be overdone.

The system of numbering the highways has proved to be very satisfactory. The principal highways are now called by their numbers just as naturally as people call trains by number. For instance, if one asks in Madison the road to Wausau, he will be told, "Take State Trunk Highway No. 10," or if one is in Milwaukee and wishes to go to Fond du Lac, they will tell him just as naturally to "Take No. 15," and so on.

County Line Signs and Mile Posts.—We have erected county-line signs and state-line signs giving the name of the two counties and the county highway commissioner's name and address. On the same principle, every patrol section has a sign at each end, giving the name of the patrolman each way from that point. These two types of signs are placed so that the traveler may know who is responsible for the maintenance of the section of road over which he has just passed and of the section into which he is passing. We have found these signs very valuable in stimulating the natural spirit of competition and pride which should exist in patrol work.

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*[illegible] presented [illegible] before the [illegible] Highway Congress, [illegible]

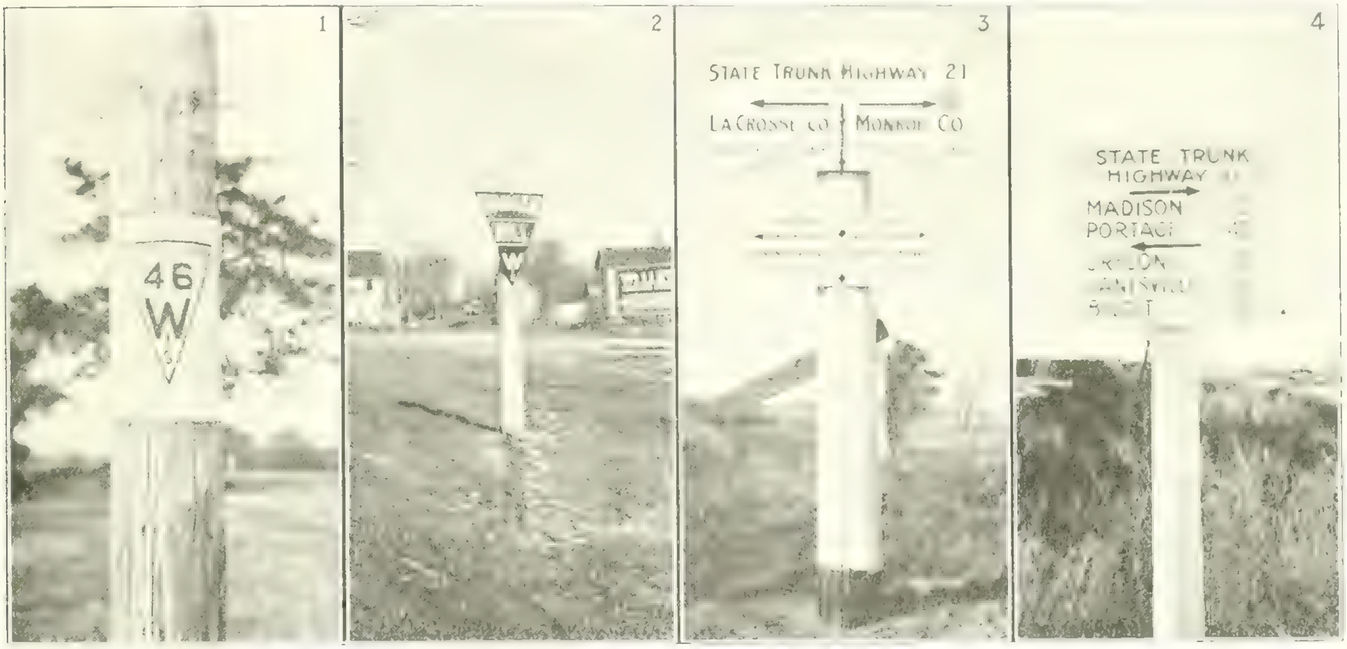
We have also set up standard mile-posts or markers showing the state trunk highway standard design and number and the mile number measured from the east or south end of that especial state trunk highway. These mile-posts serve to tie our office records to the road itself, and also enable any traveler [illegible] good or bad conditions to boost or to complain to us as the case may demand, and enable us to locate the exact place mentioned. Culverts and bridges are numbered and tied into the mile numbers: thus, the first culvert in mile number 25 on trunk highway 10 is 10-25-1, and the first bridge is 10-25-11, etc. All mile-posts are of wood and cost us about $1.50 each, erected. We are erecting about 2,000 direction signs. These are board signs painted white, with black lettering. They are divided into "on system signs"—that is, signs at intersections directing both ways to places on that state trunk highway or beyond, and giving the mileage—and "off system signs," located at intersections with other roads and directing to important points not on the state trunk highway system. These "off system signs" are located only at the intersection with the one road which should be taken from the state trunk highway to the point in question. A lecture could be given on the danger of indiscriminate signing, where several consecutive intersections give directions to a certain point when only one road should be used to get to that point. In brief, we believe that indiscriminately located direction signs do more harm than good.

We have also designed and have had made special metal danger signs for railroad grade crossings and dangerous hills and curves. These are the only metal signs we have used, and cost us $1.36½ each, f.o.b. Madison. Caution signs stenciled on telephone poles or other convenient objects are used where there is no real danger if reasonable care is exercised.

Direction signs and all other signs are erected on wooden or concrete posts painted white. All posts and the mile markers should be erected as close to the traveled way as is possible without interfering with maintenance operations or being dangerous to travel. This is necessary in order to bring them within the area of motor-vehicle lights at night, when the markers on telephone poles are sometimes hard to catch.

Protection Markings for Bridges and Culverts.—In addition to the above, all of which serve to outline the course of the system in one way or the other, we expect in 1919 to paint or whitewash the end walls of all culverts, the end posts of all bridges, to place posts painted white at the end of all culverts without end walls, and where the fills are not high and we have no guard rails we shall outline the [illegible] of the fills with stone painted white or with occasional white posts. This epidemic of white along the state trunk highways will be an additional distinctive marking and help travelers to follow the system, especially at night, besides serving the first essential purpose of indicating points of danger on the edge of the road. Some of our counties have this year done much of this kind of work, and it has been found very effective for night travel.

Including the marking of the triangles (costing $9,000) the total cost of marking, signing and protecting the state trunk highway system will be $25,000, or at the rate of $5 per mile. We believe that this expense, and much more, can be fully justified by the results attained. Our people are well satisfied with the system of marking and signing used, and we have received many compliments from travelers from other states who have passed through Wisconsin.



Standard Signs and Markers Used on the State Trunk Railway System of Wisconsin.

Fig. 1 shows the standard device employed for marking the state trunk system. It is placed on each side of mile posts, on telephone poles and other convenient places. The standard danger sign (Fig. 2) is placed at railroad crossings, dangerous curves and hills, the words "Railroad Crossing" or "Curve" being substituted for the word "Hill" shown in the illustration. The county line sign (Fig. 3) shows the boundary line of the two counties with the name of the County Highway Commissioner who is in charge of the maintenance of the trunk system in each county. Below the county line system is attached the patrol section sign, which in this case appears at the county line. The patrol section sign shows the number of each section and the name and address of the patrolman. These signs are placed at the limits of each patrol section and are very valuable in placing responsibility on the man actually in charge of each section. Fig. 4 is the standard two way "on system" direction sign. Signs similar to this are placed at important road intersections along the trunk system directing the travel to towns on the system. Similar signs without the state trunk highway heading are used to direct travel to towns off the state trunk system and are called "off system signs."

Bids Not Limited by Engineer's Estimates.—The Superior Court of Ohio has handed down a decision that the city authorities have a right to award a contract for street improvements even though the lowest bidder was above the estimate made by the city engineer. Heretofore it has been a custom to readvertise for bids when no bid was as low as the engineer's estimate. The court held, however, that this was purely a custom and not mandatory and that in these days of fluctuating prices it would be difficult for an engineer to give an estimate that would be really worth something three or four months later.

Effect of Good Roads on Farm Values

Good roads enthusiasts are almost daily asked the question: "Is the building of good roads a business proposition? Does the capital invested in permanent highways return dividends, and if so, how much are these dividends?" These questions are answered as follows by State Highway Commissioner R. S. Tiernan of Fort Scott, Kan., in the January issue of Kansas Highways.

There is good reason why this question is so frequently asked. The dividends which are returned from capital invested in permanent roads are often more difficult to accurately figure than dividends returned from other forms of investment capital. A person can invest in a tractor. He knows its cost; he can accurately figure the cost of maintenance, depreciation and of operation. He can easily compute in dollars and cents the work which the tractor does, and can readily discover whether or not he receives dividends on the capital invested in it. On the other hand, a person makes an investment in a permanent road. Although he knows exactly what the original cost of the road is, the cost of maintenance, the depreciation, and the actual returns in dollars and cents are often more or less uncertain and indefinite. Accordingly, the dividends from the capital invested in the good roads are more difficult to ascertain.

As a general proposition, capital invested in good roads returns bigger dividends than capital invested in any other form of improvements. Nevertheless, it is always true that the returns from a good-road investment vary according to the locality, the kind of construction, and the circumstances of the individuals who make use of it. A certain good-road improvement will return big dividends to a certain community, while to another community a similar improvement will return small dividends, or possibly none at all. Likewise, a good-road improvement may be of great value to certain individuals in the community, while to others its value is small. Whether or not a permanent highway investment will bring dividends to a community will depend entirely upon the amount of business and the kind of business which the highway will carry.

There are several direct benefits which usually come from the building of good roads and directly cause the capital invested to return large dividends. These benefits are the immediate increase in land values, the possibility of marketing when prices are highest, the making of new markets available, and the increase in the amount of load hauled. Actual cases illustrating these benefits are interesting.

During the last 10 years this community has invested a considerable amount of capital in highways. The farm land upon these improved highways has increased from $5 to $25 an acre immediately upon the completion of the road. A fair average increase would be $10. Even if the permanent road cost the land-owner $2 an acre, there would still be a profit of $8 an acre immediately upon the construction of the highway.

The hard-surface road invariably permits the farmer to market his crops when the prices are the highest. This fact is illustrated by the following case: During the winter of 1916 a certain farmer in this community stated that had he been able to haul his oats to market during the time the roads were impassable he could have obtained 15 ct. more a bushel than he received when it was possible for him to market his crop. His oat crop made 40 bu. to the acre, so by not having the use of a permanent highway to market he lost $6 an acre from the sale of his crop for one year. He could have paid $2 an acre for a permanent highway and still had a profit of $4 on every acre he had planted in oats.

A permanent highway by or near a farm makes available markets that otherwise cannot be taken advantage of. The following case which recently occurred in this community splendidly illustrates this case. A farmer living at a distance of 20 miles desired to sell his milk to a condensery. He accordingly arranged to have the milk delivered upon a truck. A few days after the delivery was started the roads became impassable for the truck, and he was compelled to discontinue the sale of the milk upon the condensery market. On account of the lack of a hard-surfaced road he lost the benefit of a milk market which would have returned him 5 ct. more a gallon net for his milk than he otherwise received. On an average production of 20 gal. of milk daily throughout the year, his annual loss in milk sales would amount to $365.

The increased amount of load possible when a good road is available is one of the greatest factors in making good roads a profitable investment. A few years ago a permanent highway was built past an 800-acre farm which is situated a few miles from town. With the same motive power and with less expense of maintenance, the farmer operating this farm increased his annual haul 1,000 tons. Figuring the cost of hauling at 50 ct. per ton, on this one item alone the value of the permanent highway to the land-owner was annually $500.

Innumerable cases can be given showing the actual cash returns which a permanent highway brings. Proof is everywhere that even without considering the social, moral, and intellectual benefits of good roads and the special community benefits through additional trade and business that road building brings, the construction of good roads is a profitable investment.

Today permanent highway construction is the thought uppermost in the minds of the rural population of the state. Everywhere the question is being asked, Do good roads pay, and if so, how much? A study of the communities that have constructed good roads will readily prove that good roads pay; that they pay better for some communities and for some individuals than others; that certain kinds of construction pay better than others. All good-road advocates are urging that the people of this state make a study of road building as a business proposition; that they figure out where the roads and what kind of roads will return the largest dividends, and that they bend every effort to immediately provide for the construction of such roads.

Steel Roller 5 Ft. Diameter and 1 Ton Weight for Rolling Concrete Roads

A 5-ft. diameter, 2,000-lb. roller, is employed by J. W White, County Highway Engineer of Monroe County, Michigan, in rolling concrete. The first roller used was made of 2-in. plank, was 32 in. in diameter and 15½ ft. long and weighed 2,200 lb. This roller had a tendency to make the concrete wavy, which was attributed to the small diameter, so the larger one was constructed. The surfaces of both rollers were concave so as to give the requisite crown to the roadbed. The large roller is made of steel and cost a little over $400. Mr. White states that their experience would indicate that one roller could be depended upon to roll several hundred miles of concrete without wearing out. During the 1918 season 10 miles of concrete was rolled. It was found that the rolling compressed a 5-in. slab between ¼ and ⅜ in., and that the surface of the rolled slab was as true as the average concrete road surface. The roller picks up the mortar just enough to leave a pebbled effect which forms a good base for the asphalt top. For the finishing operations Mr. White has a templet which rides on the forms and is dragged ahead by the mixer. When 15 or 20 ft. of concrete have been spread the roller is rolled back and forth an average of three times.

Would Abolish Office of County Engineer in Washington. A bill will be introduced in the State Legislature in Washington to abolish the office of county engineer and to substitute a superintendent of highways appointed by the county commissioners and to serve as long as he makes good. This bill would make the county commissioners agents of the state highway department and require that they appoint a competent engineer with 5 years experience as highway superintendent, the state to pay the superintendent $100 a month and the county such other salary as may be necessary, not to exceed $5,000 a year.

Method of Constructing Smooth Top Concrete Base for Wood Block Paving

By ELLIS R. DUTTON,

Assistant City Engineer, Minneapolis, Minn.

Convinced by observation and also by theory that the laying of creosoted wood block paving on a smooth top concrete with a bituminous cushion was the best method of construction, we began to lay this class of paving that way in the season of 1918.

The only objection we have had as to this way of laying blocks was the added cost entailed by reason of getting a smooth top concrete. There was no question as to its possible superiority to the mortar or sand cushion, but how to do it was the question. We have had very little trouble from our method of using a sand cushion here in Minneapolis and we have laid over 2,000,000 sq. yd. of creosoted wood block pavements in this way since 1902. We are, however, beginning to have some trouble from some of our older pavements on account of the water getting in under the blocks and causing expansion. This difficulty can be attributed more to the method employed in cleaning, using squeegees and power flushing thereby keeping the pavement continuously wet and very wet most of the time.

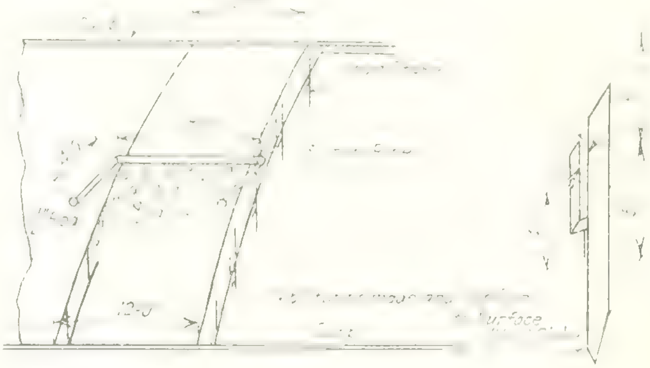
There has been many suggestions made at various times and places as to the best method of securing a smooth top concrete and we started in to try out several methods. We began experimenting with templates made to the proper crown of the street, having iron stakes attached to hold them to the proper elevation. We used a screed drawn over the templates, but on account of the larger aggregates it was difficult to bring the concrete to the proper grade. We then used a large iron roller about 10 in. in diameter and 6 ft. in length having a long handle and drawn by hand across the screeded concrete. This worked fairly well, but would leave marks in the concrete. We then used a belt to obliterate the marks, but this was not entirely successful.

We obtained the best results by the use of the templates and a small sized roller to smooth the top of the concrete as shown in the accompanying illustration.

The roller was made from a 3-in. wrought iron pipe 13 ft. long filled with sand to increase its weight. The handles were fastened to a round block of hard wood about 6 in. long which were driven into the ends of the pipe. The templates were made from 1x6-in. lumber, 4 pieces for each complete template, the upper edge being finished to the contour of the street. It requires at least 3 templates for working continuously. These templates were placed 12 ft. apart longitudinally of the street as that was about the limit of the amount of concrete that could be handled by a concrete mixer using a 20-ft. boom. The templates were held to the proper grade by iron stakes with brackets driven into the ground. The stakes were made from 1½-in. x ¼-in. flat iron in the form as shown in the drawing. There was also required a removable bridge from which the workman removed the templates from the finished section and from which he filled the space caused by such removal and finished the filled in material with an ordinary long-handled float.

Pipe Roller Used at Minneapolis on Smooth Top Concrete Base

By the use of the above described equipment we could do the work almost as rapidly as on ordinary concrete and the cost was only a little higher, taking into consideration the fact that there was no sand or mortar cushion to be laid.



Method of Using Template and Roller.

Bamboo Roads in Burma

A method of building roads employed in Burma that may be applicable for use in other tropical localities is described by Mr. Harley E. Harper in the Engineering & Mining Journal, from which the matter following is taken:

In the Tavoy district, Lower Burma, the rainfall during the monsoon season is exceptionally heavy. In the middle of this season, it was necessary to haul wolfram ore over 10 miles of jungle road which the bull-cart traffic had reduced to a series of morasses or bogs. The road was first corduroyed with 3-in. and 4-in. saplings and these were covered with a few inches of laterite. In carting the laterite, the few good portions of the road were badly cut up and the job was costing about $28.80 per 100 ft.

Bamboos of 2-in. diameter were split into four sections and laid longitudinally, at 1-ft. centers, along the road. Similar quarter sticks were closely woven, in sets of two, across the longitudinal strips, two over and two under. The alternate longitudinals were held up while the cross pairs were put in and then tapped back into position. The contract for the road, including the rough leveling, was let at $5.76 per 100 ft. and 100 coolies could cut and lay 1,000 ft. per day. The hard, external part of the bamboo was always laid upward.

To split the bamboo, a rough cross is erected, about 3 ft. above the ground and against a firm wooden frame. The end of the bamboo is slightly split twice with a dah, and the four pieces are thrust through the angles of the cross with a good push.

An elephant hitched to an improvised cart, made from the steel wheels of a portable engine, formed part of the transport kit, and he negotiated the bamboo matting repeatedly, leaving no visible impression. Owing to the naturally uneven length of the longitudinals, the joints are staggered, thus making a continuous semi-elastic mat hundreds of feet long. It is an improvement to pin down the sides, but not an absolute necessity. The sharp curves in the road are covered without any noticeable irregularity in the matting. The mud works up slightly in the softest parts, but the heavy rains wash it down again, and the mat usually presents a clean and orderly appearance. Such a track will last from four to five months, sufficient to see one well through the monsoon period and give a chance for road repairs to be made during the dry season.

Suggested Procedure for Machine Flushing in Street Cleaning

[illegible] are given in a report on street cleaning at Rochester, N. Y., [illegible] Municipal Research, [illegible] is Chief Engineer. [illegible] is taken from this report.

Motor Flushing Practice and Costs at Rochester.—In 1916 [illegible] gal. capacity, [illegible] capacity was put [illegible] on a 5-ton truck [illegible]. A comparison of the two flushers follows:

	Flusher No. 1	Flusher No. 2
[illegible]	[illegible]	[illegible]
3 nozzles	18 to 23 lb.	26 to 30 lb.
[illegible]	[illegible]	[illegible]

The two machines are used for flushing some of the main streets. Two men, a driver and an assistant, are used on each machine. The assistant makes the hydrant connections and operates the nozzle levers. When the 1917 season started the flushing was done with new operators on the machines. Both men were experienced motor drivers, but neither knew anything about street flushing; as a consequence they did not always obtain the best possible results.

During the four months, June, July, August and September, 1917, the two machines flushed a total of 12,399,734 sq. yd. of pavement, the total number of flushing miles traveled being 1,319.18, of which machine No. 1 covered 533.52 and machine No. 2 785.66. The average cost per 1000 sq. yd. for the flushing was 9.62 ct. This figure does not include the costs of the water. An average of 338.6 gal. of water was used per 1000 sq. yd. flushed. The average yardage flushed per hour amounted to 14.515 sq. yd. Of the total yardage flushed, 5,777,000 was asphalt pavement, 600,000 sq. yd. of Medina block and 6,000,000 sq. yd. asphalt and Medina block. On the asphalt pavement the average number of gallons of water used per 1000 sq. yd. was 299.2, and the average yardage covered was 14.976 sq. yd. per hour. The average cost per 1000 sq. yd. was 10.124. In flushing the Medina block an average of 365.4 gal. of water per 1000 sq. yd. was used. The average yardage flushed per hour was 13.171 sq. yd. The average cost was 8.57 ct. per 1000 sq. yd. The cost of operating the flushers for the four months was as follows:

	No. 1 machine	No. 2 machine
[illegible]	[illegible]	[illegible]
Miles flushed per gal. gas	1.375	1.471
[illegible]	[illegible]	[illegible]

[illegible] for No. 2 [illegible] gal. for No. 1 and 30 gal. for No. 2.

General Comments as to Motor Flushing.—In general, it appears, as a result of tests made, that only two nozzles should be used together on either flusher. In order to save one trip, three nozzles may be used on a narrow street or for flushing the center of a very wide street, if an effective pressure can still be maintained. This qualification is important because it was found that where three nozzles were used together instead of two, less effective pressures, and consequently less side wash, were obtained. The result was that dirty spaces sometimes were left near the center of the street. When four nozzles were used together, water was wasted and, moreover, the nozzles were not all effective, because the two in front interfered with each other and pushed the water straight ahead instead of to one side. The resultant loss of pressure alone is sufficient cause to prohibit the use of four nozzles together at any time, with these machines. A suggested combination of nozzles for different conditions is indicated in Fig. 1.

The relative value of the nozzles also was given attention in the tests, because there are two sizes of openings in the fan-shaped nozzles on flusher No. 2. The two nozzles with the smaller openings gave the best results because the wider openings wasted water. When the two wide nozzles were in use, the gage indicated 5 lb. less pressure because the pump had less resistance to work against. The openings of the wide nozzles should be reduced in size. The manufacturer states that this can be done without difficulty by means of a vise.

The effectiveness of flushing was found to be less up grade, on account of the slower speed. This is because the pumps are directly connected to the main shafts, and the pressure maintained is dependent on the rotary speed of the shaft. When flushing up grade it is best, therefore, to reduce the load by having the tank only partly filled.

The nozzles are operated from the front seat by four hand levers; the two in the center controlling the front nozzles, the outside levers controlling the rear nozzles. The nozzles should be adjusted so that the water from the rear nozzle on either side will pick up the stroke of the front nozzle on the same side. When three nozzles are used, ordinarily there should be two flushing to the right and one to the left. The two front nozzles on these machines should never be used together, because water would be wasted, pressure reduced and but little side wash obtained. Usually only two nozzles should be used at a time. Sometimes the use of three will flush a narrow street in one trip or will save a trip on a very wide street, but always with a reduction in pressure. The pressure gages should be so placed that the drivers can see them while driving.

For regular street sprinkling work, two suitable nozzles are connected to the front flushing nozzle pipes and are operated by using the two center levers. The water is diverted from the flushing nozzles to the sprinkling nozzles by a quarter turn of the valve nut behind them. In sprinkling or flushing, the quantity of water used can be regulated only by the speed of the machine, as the valves cannot be partially closed. Only one sprinkling nozzle should be used at a time. It should be set so that the top holes are at the same height on both sides of the nozzle.

The efficient operation of flusher trucks depends to a large extent on the drivers, who have expensive pieces of apparatus in their care. Flushers will give good service only when carefully handled and kept in good repair.

Motor Flushing Results.—The cleaning results obtained by motor flushing, with 30 lb. pressure or more, proved to be very satisfactory on asphalt streets. This was not the case, however, on Medina block pavements. These pavements are laid on a sand cushion,* and the joints of most of them are not grouted; hence the sand and dirt work up from the bottom through the interstices and make them difficult to clean and hard to keep clean. Where car tracks are paved with Medina blocks without a concrete base, the area included is still harder to clean, because the rails are all on a level, and because dirt and sand deposited on the rails are caught in the grooves. On a rainy day it can be seen plainly how much cleaner are the sides of such streets than is the car track area.

As the motor flushing results obtained on these Medina block car track streets were not all that might be desired, means should be provided for improving the work. With the present apparatus, better results could be obtained by making more trips on such streets. The flushing strokes then could be lapped more. This would make them narrower and more effective, because the side throw would not have to be so far for each individual stroke. (Increasing the number of trips, of course, would increase the cost in direct proportion to the number of extra trips.)

In order to aid in obtaining the desired results, diagrams, based on past performances of the local motor flushing apparatus and needs, have been prepared in the hope that they may be adopted for the guidance of flusher operators. These proposed procedure diagrams, for motor flushers producing a maximum pump pressure of 40 lb. are shown as Fig. 1. If additional flushers are purchased, higher working pressures should be specified. The use of such apparatus would necessitate a modification of the suggested procedure, as fewer trips would then be necessary to obtain the same results. Higher pressures thus would tend also to reduce the unit costs for the work.

As experience elsewhere has proved that on rough pavements the best results can be obtained by hose flushing, it is suggested that certain Medina block pavements be flushed by hose rather than by machine, even if the suggested procedure for motor flushers be adopted and new machines are purchased. Streets paved with Medina block require the use of more water, because they are rougher and dirtier than other pavements. With hose, the water can be concentrated on the dirty spots, and rough places can be given special attention.

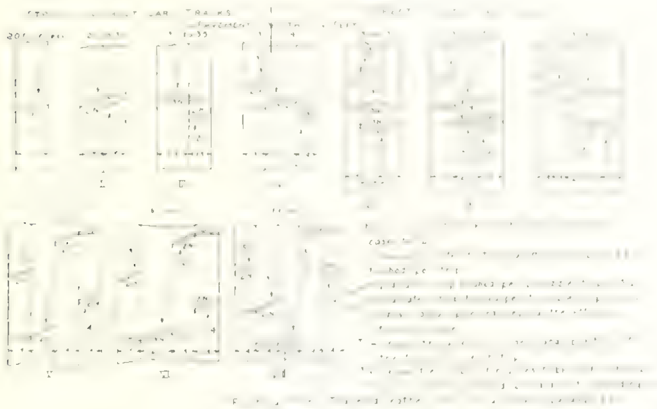


Fig. 1—Proposed Machine Flushing Procedure for Equipment Developing a Maximum of 40-lb. Pressure

Suggestions for Bettering the Service.—The following suggestions are made with reference to obtaining better results from present equipment, as well as to point out desirable factors in purchasing and operating new equipment:

As much valuable time is lost in filling the tanks with water, 4-in. intake pipes and hose, instead of the 2½-in. size now used, would save considerable time. It takes 7½ minutes to stop and fill a 1500-gal. tank, and only 3½ minutes to empty it. Many of the local hydrants now have 4-in. connections, and 4-in. strainers and hose can be obtained on specifications. A recent quotation on 4-in. rubber hose capable of withstanding 140 lb. pressure was $2.21 per foot, without connections. It weighs 2 lb. per lineal foot. This question should be given consideration in purchasing new equipment.

Mileage records are necessary for obtaining good cost data. No speedometers are used on the flushers, and it has been shown that they are hard to keep in order, on account of the vibrations of the trucks. However, hub odometers will give satisfactory service on trucks of this size, and should be supplied so that the proper records can be kept.

A worth while saving could be made in gasoline consumption if the motors were stopped while the tanks are being filled, which is approximately one-half of the time. As starters are little used on heavy trucks, the engine would have to be cranked 25 or 30 times a shift in such an event.

The following data were obtained from a consumption test on the No. 2 flusher to determine the amount of gasoline wasted by running the engine while filling the water tanks:

Total time of test............	1 hr. 17½ min.
Less time not running........	11 min.
Time to consume ½ gal.......	1 hr. 6½ min. including [illegible] starts
Time to consume 1 gal........	2 hr. 13 min. or 133 minutes

At 7½ minutes a filling for 28 fillings per 7-hour shift, the flusher is standing 210 minutes. This means that the machine is standing half the time and is then consuming one gallon every 133 minutes. For 210 minutes a shift, the possible saving should be 1.58 gal. For the 65 shifts in a season, the saving would be 102.7 gal., costing $26.70 with gasoline at 26 ct. a gallon. The total gasoline cost for this one truck for the 1917 season was $142.71, and if this were reduced by $26.70 there would be a saving of 18.7 per cent. This saving, of course, would be multiplied by more extensive use of one flusher and by the use of several flushers.

The life of hose could be prolonged if more care were exercised in turning on the hydrants slowly, and also if hanging the hose over one hook were discontinued. If possible, the hose should be hung around the tank of the flusher without kinks. (These points are largely matters of instruction and discipline which should be given constant attention.)

Sometimes sprinkling 15 to 30 minutes before flushing would increase the effectiveness of the results obtained, especially in removing horse droppings. This would soften up the dirt, which then could be flushed off readily. The frequent rains and wagon sprinkling made sprinkling ahead of flushing less necessary last year than usual. However, the necessity for sprinkling should be determined by the judgment of the man directly in charge of the flushing work.

It is believed that a flusher having a capacity of 1500 gal. is the largest size desirable for Rochester, as a weight much greater than 12½ tons is likely to prove detrimental to the pavements.

Two flushers which could maintain the same speed could be used to advantage in a battery on the wide streets. If this were done, the less frequented streets could be flushed first and the others done in the early morning hours, when there would be no serious delays from vehicular traffic.

It cannot be expected that the best results will be obtained if the work is done without competent supervision in the field. The work done by each flusher should be studied and analyzed under the various conditions to be met, and the work should be planned so as to get the best results possible from each machine. If this is to be accomplished, the night flushing work must be under the direction of a night superintendent who understands the work thoroughly and who can develop it to meet local conditions satisfactorily.

"Don'ts for Motor Flusher Operators."—The following "Don'ts" are suggested for the observance of motor flusher operators and helpers:

Don't waste water.

Don't forget to close hydrants.

Don't use too much force to open hydrants.

Don't forget to use burlap spray shields on leaky hydrants and hose.

Don't wet pedestrians.

Don't forget to shut off nozzles when blocked by traffic, when horses become frightened and when not flushing.

Don't forget to report damaged hydrants to the superintendent.

Don't forget to blow your horn when approaching vehicles, corners or people standing near the curb or on the street.

Don't let the engine run when not in use or when filling tanks.

Don't open hydrants too rapidly, because it damages the hose.

Don't forget to keep kinks out of hose connections.

Winter Dragging of Roads.—Drag the roads during every thaw, urges the Service Bulletin of the Iowa State Highway Commission. No dragging of the year gives better returns in good roads than the winter dragging when the road surface is softened by a thaw. There is no road on earth better to drive on than the dirt road frozen up perfectly smooth and solid. If the road surface is allowed to remain rough the water from the melting snows next spring will stand in the rough spots and ruts instead of flowing away to the roadside with the result that the spring break-up will probably be one of the old fashioned kind with the roads almost impassable for weeks. A road which is allowed to go all to pieces during the spring break-up requires a through blade treatment to put it into shape for the year's traffic.

Financing Highway Construction and Maintenance by License Fees for Motor Vehicles*

[illegible]

[illegible]

[illegible] should be the [illegible] truth, that [illegible] the kernel of our per[illegible] improved highways and in what [illegible] the economics of tax[illegible]. They run the gamut [illegible] entire cost of highway construction and maintenance upon the direct users of the roads, to those who would exempt them and make the general public foot the total bill. In between are the various degrees of compromise, all of them advocating, in different ratio, some tax on the public and some on the vehicles. To prepare the way for this middle group let us briefly consider the arguments of the two extremes. Many of them appear in replies to a questionnaire that I sent to a number of state highway officials and to representatives of automobile associations and industries.

Placing Entire Cost on the Public.—The strong plea for exempting the direct users of roads and placing the entire cost upon the public, is, of course, that the public is ultimately the great beneficiary.

I may never own a car, or ride in one, but when my child is taken critically ill, his life may depend upon the speed of the good road over which the doctor can reach him. Shall I hesitate to pay my share toward it?

I may never have letters to send or goods to export, yet inevitably the life of my household and business depend upon the receipt of supplies from without. Shall I not help pay for the route over which they travel?

Even though I may never use the public schools I gladly pay the school tax, because through education it enhances the life of the community, and hence my own welfare.

I pay for police and fire protection though personally I may never need either, and I don't demand that people whose houses burn up or who have burglars arrested shall pay a special fee. Should I not be willing, as one of the public, to pay for the public benefits derived from good roads, especially as I am bound to receive from them not only a share in the general good, but direct personal advantages?

The argument sounds convincing. It is ably supported by Mr. George Diehl, of the American Automobile Association.

An interesting suggestion for application of the entire tax upon the public is made by Mr. Ellis Dutton. Land bordering the highway whose value is directly increased by it shall carry the greatest burden of expense; contiguous lands and the general public less, proportioned as far as possible upon the benefits they receive. Says Mr. Dutton: "In every case where streets or roads are paved, the increased value of the property is more than the cost of the improvement. Shouldn't these benefited lands pay for the paving * * * * and in less proportion, contiguous lands and the general public?"

But as in the case of so many other convincing arguments, there is a practical difficulty, not insuperable perhaps, but considerable. The traffic demands for and upon highways are greater than the tax paying power of the public can sustain. More and more traffic—an increase in New York State of 390 per cent in motor vehicles in the last 7 years—more need for new routes and good maintenance, higher and higher taxes, until the point is reached where the increased cost of the roads does not yield the tax payers a commensurate return in public benefits. The gain accrues to private pocketbooks. Thence we swing to the opposite extreme that says that the motor vehicles using the roads and directly profiting from them should be the ones to pay for them. I purposely omit horse drawn traffic here, as being an increasingly negligible factor upon our highways.

Placing entire cost of improvement on motor vehicles Illinois is the chief exponent of taxing motor traffic for entire cost of the highways.

The arguments advanced by Mr Bradt of Illinois in favor of their arrangements are.

1. The practical difficulties of raising money through a general public tax. The political party in power, particularly in election year, is so anxious to keep down taxes that it is loath to secure funds for absolutely necessary work. The tax burden in Illinois is already very heavy.

2. The greatest benefits from the roads accrue to the direct users of them. Motorists gain directly through the lower cost of running on good roads. Hence the user should pay.

3. The public really pays a share through the increased cost of service and commodities received over these highways.

On the strength of these arguments, Illinois has authorized bonds for $60,000,000 for highway improvement, all of which will be paid from automobile, dealers', motorcycle and chauffeurs' license fees, the greater part being derived from automobile fees. The system to be built from this sum will extend 4800 miles, and it is estimated will carry forty to fifty per cent of the total state traffic. It comprises, however, only 5 per cent of the total road mileage. The other 95 per cent will have to be maintained and improved through general taxation.

So even the state that has gone farthest in taxing vehicles for highway purposes has stopped short of the ultimate, 95 per cent in mileage and 50 per cent in traffic.

Objections to Putting Entire Cost on Motor Vehicle Owners.—The practical objections to putting the whole cost of the highways upon motor car users are obvious. In the first place, even if it were practicable, it wouldn't work—which isn't quite so much of a bull as it sounds. It wouldn't work because of argument No. 3. All cars engaged in any kind of public service—by far the greater and more destructive number when you include the motor trucks—would immediately charge the expense of the fee to the cost of their service, increasing the price to the consumer, so that the public would be paying just the same, only a little more so, for the benefits it receives via the highway route. Indirect taxation may tickle the palate, but it's fundamentally bad for financial digestion. The relatively small number of car owners who do not perform any public service for which they charge would bear the brunt of disproportionately high taxation. This immediately raises the question of how far we believe in class taxation. Is it, or is it not justifiable?

Moreover, I don't believe it is generally practicable to raise highway funds exclusively through taxation or vehicles. It would tend to limit the number of vehicles, and the fewer these were the more each one would have to pay, until the limit that any one could endure would be reached. Then the roads would have to suffer—less new construction, poorer maintenance, until the public, realizing that the loss of good roads was costing far more than the taxes necessary to sustain them, would rise up and demand that they be continuel.

Dividing the Cost Between the Public and the Direct Users of the Roads.—It is really the theory of marginal utility that adjusts the difference between the two extremes and offers us a working basis. The public is willing to pay up to the margin where the utility it receives from the road compensates the money outlay in taxes. Beyond that it cannot economically go. But so great is the destruction of the roads under heavy traffic that taxes on this basis will not meet the entire cost of maintenance and desirable new construction.* The difference must probably be met by a tax on vehicles. Now the vehicles are willing to pay up to the margin where the tax levied upon them is commensurate with the especial value that they, as direct users, receive from the road in distinction from the non-direct using public. Believing, therefore, that both classes of beneficiaries should contribute toward the support of highways, it remains to adjust the balance between them.

The point of marginal utility for the public seems to be reached at paying for the construction of new roads. The cost of these is great, so is the immediate benefits derived by the public. More exactly than such balances can usually be made, the point of marginal utility for the vehicles seems to be reached at paying for maintenance. The cost of maintenance is great—so also is the damge done by motor vehicles to roads for which the public has paid. I make these two statements a priori, from a study of cost data and of the means taken by the different states to raise the necessary funds for highway purposes. They are, of course, open to dispute. I offer them as an hypothesis, because motor truck fees must be considered in relation to the objects for which they will be used.

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*[illegible] Highway Congress, Chicago.

Motor Vehicle Fees and Road Maintenance.—If we consider the fees in relation to maintenance, Connecticut offers us some interesting experience. The Commissioner there is working on the theory that the income from motor fees should approach the outgo for maintenance.

Here are the schedules of Connecticut's heaviest revenue producers in fees:

For passenger cars, 50 cents per H.P. per annum;

For commercial vehicles up to 1000 lb., $11 per annum.

One ton, $15 per annum;

Then an increase of $5 per ½ ton to the 3-ton weight, $35;

Then an increase of $10 per ½ ton to the 5-ton weight, $75;

Then an increase of $12.50 per ½ ton to the 7-ton weight, $125;

Seven and one-half tons, $150 per annum;

Eight tons, $200 per annum;

Then for each additional ton or a fraction over a ton, $100;

Each motor cycle, $2;

Each chauffeur or operator, $2.

Here are the schedules of New York's heaviest revenue producers in fees:

Passenger cars, 25 H. P., $5 per annum;

25 to 35 H. P., $10 per annum;

35 to 50 H. P., $15;

50 H. P. or more, $25;

For commercial vehicles, 2 tons or less, $10 per annum;

Then an increase of $5 per ton up to 14 tons, which is $70; for each ton over 14, $10 per ton;

For trailers of 2 tons or less, $5 per annum;

2 to 5 tons, $10;

5 to 7 tons, $15;

7 to 10 tons, $20;

10 to 14 tons, $30;

And $5 for each ton above 14.

For passenger omnibuses:

PASSENGERS.

Up to 5	$15.00
Not less than 6 nor more than 7	21.50
Not less than 8 nor more than 10	30.50
Not less than 11 nor more than 16	43.00
Not less than 17 nor more than 20	52.00
Not less than 21 nor more than 22	55.00
Not less than 23 nor more than 26	61.50
Not less than 27 nor more than 30	67.50

And an additional $2 for each passenger over thirty.

Motor cycles, $2.50;

Chauffeurs, $5 first year; $3 for license; $2 for examination; renewal, $2.

According to motor car owners with whom I have talked, these fees are paid willingly, both as a matter of abstract justice in repairing the damage done by the vehicles themselves, and as a matter of personal interest to the motorist. Through the payment of fees for maintenance of good roads they assure themselves that they will lower operating expenses, decrease hazards, and curtail delays.

But, here is an important point in considering motor car fees in relation to maintenance. The cost of maintenance depends upon the efficiency of your highway department. Put in incompetents or grafters, and the fees will either go beyond bounds or the maintenance will fall short. The general public is not yet educated to knowledge of and insistence upon the best use of the taxes it pays. It is all up to the motor car users and industries to see that the money for highway purposes be expended by honest men of proven ability. Whether they like to or not they must concern themselves in politics to the extent of securing good highway men in the state service, for the success of their business depends upon the success of the roads and the success of the roads depends upon highway administration.

For instance, for years Mr. Bennett has been building in Connecticut durable types of pavement with maintenance charges of $100 to $200 per mile per year. A very different proposition from having waterbound macadam with a maintenance of $1000 a mile or upwards a year under heavy traffic. If motor vehicle fees are to cover maintenance, wisdom must be shown in laying permanent types of pavement for heavy traffic, so that repairs will be kept at a minimum.

The maintenance itself must be well advised and executed. Millions of dollars can be squandered on poor materials or work delayed or done at the wrong time. The proverbial stitch saves nine. The motorist must insist that repairs be promptly made, so that his fee is used to the limit of advantage. In justice to himself he can't shunt off the responsibility upon some unknown official.

In New York State motor fees are a trifle lower than those in Connecticut. For the last two years they have almost covered the cost of maintenance. Last year, fees aggregated $4,284,114; maintenance was $4,939,916. For the 9 months of this fiscal year ending Nov. 1st, 1918, fees were $4,571,852, while maintenance was over $54,000 less. Maintenance is high now because almost all our earlier roads, built to sustain traffic up to three tons, are protesting against traffic ten times that weight. The maintenance includes many complete resurfacing jobs done with durable pavements. As we build better roads, maintenance should decrease, even with increase of traffic. Motor vehicle fees can then be lowered. They will probably be close to the scale now advocated by the Highway Industries Association in its uniform motor vehicle traffic law.

Another important point to consider in relation of motor truck fees to maintenance is limitation of damage that any one vehicle may do to your pavement. It is manifestly unfair to expect all motorists to pay for the destruction done by a few excessively heavy trucks. As unfair as to expect the public to pay $50,000 a mile for new roads to sustain such trucks. There must be an arbitrary limit of load for which we can design our roads. Otherwise, as fast as they are built, roads will attract to themselves traffic heavier than they are designed to bear. The road and the load will be forever outstripping each other, with great economic loss both to the original investment in the road and in the appallingly high maintenance. In addition to regulation of weight of load, there must also be regulation of other destructive factors, such as width and kind of tires, springs, speed, etc. If, after our roads are built in accordance with those regulations, it seems in course of time desirable to put much heavier loads upon them, we may well consider the suggestion made by Mr. Whitney that we lay narrow gage tracks on either side of our pavement to carry the heavy trucks.

With these regulations, it is obviously only fair to proportion the fee to the vehicle in accordance with its probable requirements upon maintenance funds. It would not be fair to tax the little two passenger flivver the same amount as the twelve ton truck.

Mr. Nelson P. Lewis, Chief Engineer Board of Estimate and Apportionment, New York City, says: "The plan of grading the annual fee in proportion to the gross weight and carrying capacity is rational and it might well go further and make the total width of the vehicle, where such width exceeds seven feet, an element in the determination of this fee."

The fees should undoubtedly be graduated in accordance with the destructive factors to the road of the vehicle in question. Such a gradation is now made in many states. I purposely refrain from bombarding your ears with [illegible] of figures.

A graduated scale of motor vehicle fees to cover the cost of highway maintenance necessitated by the cars themselves, would not, I believe, fall too heavily upon anyone. There are, of course, objections to it, but it seems to me the fairest adjustment yet made in taxation between the vehicle and the highway, the motorist and the public.

Results of 12 Year Service Test of Experimental Wood Block Pavement at Minneapolis

In 1906 the U. S. Forest Service in cooperation with the city of Minneapolis, Minn., laid an experimental wood block pavement on Nicollet Ave., Minneapolis, for the purpose of [illegible] of various species of wood for paving material. In addition it was desired to investigate the influence of the following variables: (a) heartwood and sapwood, (b) length of blocks and (c) angle of courses. A description of this experimental pavement with observations on its conditions appeared in the April 19, 1911, issue of Engineering and Contracting. A progress report giving the result observed after 4 years' service, was printed in the Feb. 14, 1912, issue of Engineering and Contracting. A [illegible] report on this pavement, the result of investigations made after 12 years' service under heavy traffic conditions, was submitted Jan. 28 at the Wood Preservers' convention by C. H. Teesdale and J. D. MacLean, Engineering in Forest Products, U. S. Forest Products Laboratory Madison, Wis. An abstract of the report follows:

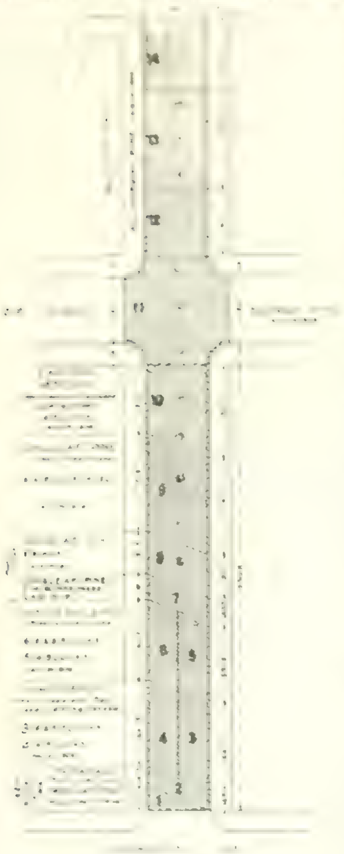

Fig. 1

Seven species of wood were employed in the experiment as follows: tamarack, Norway pine, longleaf pine, white birch, Douglas fir, western larch, and hemlock. On account of the wide use of longleaf pine as a paving material, this species was used in the test to provide a basis of comparison for the other woods.

Location and Construction of the Pavement.—The pavement was laid on Nicollet Ave. (see Fig. 1) between Washington Ave. and Second St., where it has been subjected to continuous heavy traffic. North of the intersection of Second St. three sections of Norway pine blocks were laid at angles of 45 67½ and 90° with the curb, for a comparison of angles of courses.

The pavement was laid on a 1-in. sand cushion placed over a cement foundation 5 in. deep.

The blocks were laid with close joints and rolled with a steam roller. A 1-in. expansion joint was provided at the curb. The expansion joints were filled with sand to within a short distance of the top, after which the body joints and top of the expansion joints were filled with paving pitch heated to approximately 300° F. A light top dressing of sharp sand was placed over the surface of the completed pavement.

Method of Making Inspections.—In order to determine a basis of comparison the following method was adopted:

(1) Measurement of blocks to determine the average wear.

(2) Estimation of total number of square feet in section below general level of street.

(3) Estimation of total number of square feet ½ in. or more below the general level of the pavement.

Wear of the various species was measured on a block removed from each section from a position about midway between the curb and the center of the street. This block was selected from a portion of the pavement where the surface was fairly uniform. Measurements to the nearest 1/16 in. were made at a number of points and the average depth determined. The difference between this and the original depth of the blocks was taken as the average wear of the section.

Estimates of the total number of square feet of depression below the general level of the surface, and ½ in. or more below the general level, were made independently by each member of the inspection party. These estimates were averaged and recorded.

The number of observers present at the different inspections varied from 2 to 6. While in some cases a considerable variation may be found in the estimates made by different individuals, averages of the figures obtained indicate quite clearly the relative condition of the different species. Variations in the estimates are inclined to increase as larger portions of the pavement become affected by depressions. For this reason the data were plotted for each of the inspections and curves drawn showing the average results. These curves are shown in Figs. 2 and 3.

In order to determine the relative joint wear of courses laid at different angles each member of the inspection party counted the number of depressions due to joint wear in a 50-ft. stretch of each section. The average of these determinations was taken as the number of holes in the respective sections due to joint wear. The total area of the depressions below the general level of a 50-ft. stretch of each section was estimated as described for the comparison of species.

Results of Inspections.

Comparison of Species.—In the early part of the summer of 1911 the Douglas fir blocks were in such bad condition that it was necessary to relay the two sections of this species. Deep depressions had developed and some of the blocks were badly broken. The failure of this wood after 5 years' service was probably due to the poor quality of the original blocks. In order to further test this species a quantity of Grade A material was obtained. There was not a sufficient amount of this Douglas fir to entirely replace the sections removed so the remaining

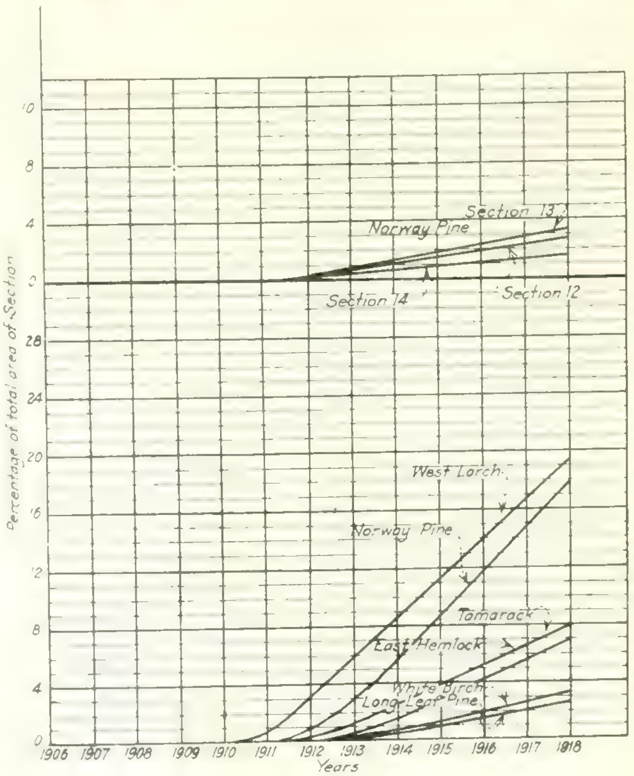

Fig. 2—Average Total Area of Depressions Below General Level of Section for Species in Sections 1 to 10 in Service 12 Years.

area was paved with the regular yellow pine blocks supplied by the city.

No replacements have been made in sections containing any of the other species with the exception of a few decayed blocks removed from the white birch sections. This decay was present in the wood before treatment, but was not detected at the time selection of the material was made.

A good comparison of the durability of Douglas fir with respect to the other species cannot be made at present as the relaid material has been in use only 7 years, while all the other species have been in use 12 years. However, at the inspections made in the last 2 years, a very rapid increase in area of local depressions was observed. While these depressions are not deep at present, the area effected is in marked contrast to the surface of the yellow pine portion laid at the same time.

Blocks of Douglas fir, which were removed for inspection, showed an average wear and brooming from 5/16 in. to ½ in. as compared with 3/16 to ¼ in. for the yellow pine placed at the same time.

It will be noted, from an inspection of the curves (Figs. 2 and 3), that it is impossible to predict the deterioration of a particular species from conditions observed during 7 or 8 years' service. Practically all of the species showed very small areas of depression for the first 5 or 6 years. After this period, however, the depressions suddenly increased in area at a very rapid rate. Results of the more recent inspection seem to indicate that the increase in depressions will be much more rapid in the future and will necessitate the replacement of some species at an early date.

There is no question but that longleaf pine and white birch are in a much better condition than most of the other species. The depressions in the white birch are somewhat more numerous and deeper than those in the longleaf pine, but these depressions are largely due to the crushing down of blocks which were partly decayed before they were treated. Depressions in the longleaf pine seemed to be due in a large degree, to decay in the sapwood of individual blocks. Poor penetration, on account of moisture in the wood at the time of treatment, probably accounts for most of the cases of decay found in the sapwood.

Apparently the white birch and longleaf pine may be classified on the basis of this experiment as about equally durable for paving purposes. An objectional feature of white birch seems to be the difficulty in selecting material free from decay. The Norway pine section has large areas of depression and a considerable number of deep pockets. The bad condition of this section, however, is not a good criterion of the wearing qualities of the species. This section is triangular in shape and therefore has but a small area which is not subjected to continually severe traffic conditions.

The section receives all of the heavy southbound traffic and is also under more severe conditions due to the turning of vehicles from Nicollet Ave. to Washington Ave. Sections 12, 13 and 14, which were laid for a comparison of angle and of courses, give a much better basis for a comparison of the durability of Norway pine. The condition of these sections would indicate that this species compares very favorably with white birch and longleaf pine. Sections 1 to 10 appear to be under more severe traffic conditions than the Norway pine sections north of Second St. This is possibly due to some of the traffic being distributed on Second St. Section 14 seems to have a somewhat smaller area of depression than sections 12 and 13. This section is at the junction of Nicollet Ave. and Hennepin Ave. Very likely this situation permits a better distribution of traffic over the entire section.

The eastern hemlock seems to be in slightly better shape than the tamarack. However, there is not a very pronounced difference in the condition of these two species. The Western larch sections are in very poor condition. Compared with the other species, this wood has the largest percentage of area affected by depressions.

Measurements of wear were taken on all of the species until 1915. At this time the depressions had reached a state where it was not practicable to select blocks representing average conditions.

In subsequent inspections a general estimate of the relative wear has been made. Beginning with the species showing the least wear at the last inspection the approximate average wear and brooming is as follows:

[illegible]

Most of the wear on longleaf pine and white birch blocks seemed to have taken place during the first 5 or 6 years of service. This was probably largely due to brooming of the fibers. Some of the other species, in which the wear was most pronounced, showed a general increase in wear from year to year.

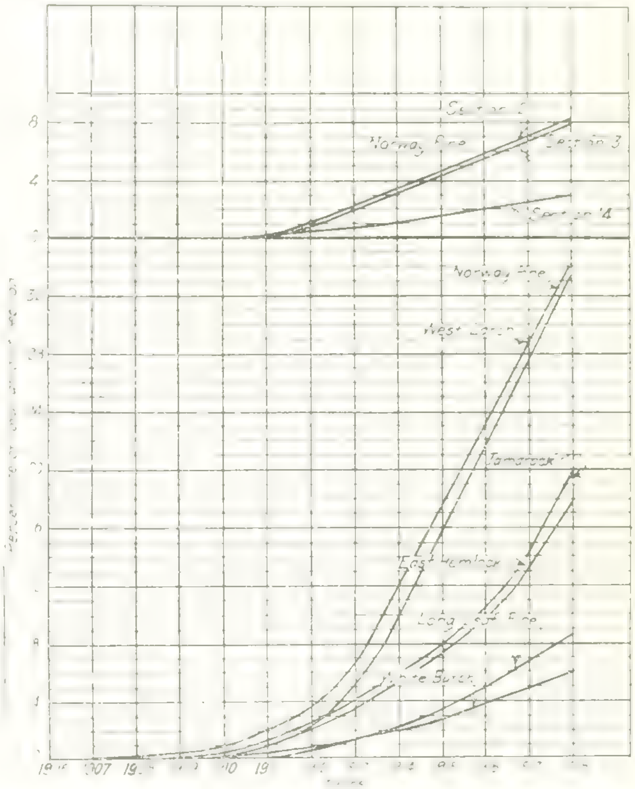

Fig. [illegible]—Average Area of Depression [illegible] In. or More Below General Level of Section for Species in Sections 1 to 10 in Service 12 Years.

Heartwood and Sapwood.—Results of the investigations do not seem to indicate that the efficiency of the pavement is materially affected by the presence of sapwood. No marked difference in the relative wear of the heartwood and sapwood was observed.

Effect of Length of Blocks.—The section of western larch blocks, 6 and 8 in. long, is not in as good condition as the section of 4-in. blocks. Apparently this condition is due to a difference in density of traffic on the two sides of the street. From the condition of blocks in other sections, the length of blocks does not seem to be an important factor affecting wear.

Angle of Courses.—Sections 13 and 14 in which the blocks are laid at angles of 45° and 67½°, respectively, show the least amount of joint wear. In the early inspections the course laid at 67½° seemed to be in better shape than the sections laid at 90° and 45° with the curb. At the present time the section laid at 90° with the curb shows the greatest amount of joint wear. Joint wear on the other two sections is about equal and results would apparently indicate that the difference between using an angle of 45° and of 67½° is of little importance. On account of the greatly increased motor traffic, the effect of the angle of courses is probably much less now than formerly.

Patrol System of Trunk Highway Maintenance in Wisconsin*

By ARTHUR R. HIRST

[illegible]

[illegible] of a pre- [illegible] should [illegible] of that system [illegible] emphasized [illegible] laid out unless [illegible] provided. The [illegible] state control with- [illegible] to say impos- [illegible] principles would [illegible] which might be [illegible]

There is much to be said for the Wisconsin system in which the state has general supervision, the county organizations carry out the details of the maintenance work in accordance with state requirements, and the state repays the cost to the counties when the work is properly done. A one year's trial of this method has worked out quite well in Wisconsin. We cannot say that it has or has not worked out as well as would a system of exclusive state control. Under the plan of organization, long established for state aid construction, county maintenance directed by the state seemed to be the logical method, and we will say that almost without exception the county organizations have co-operated wonderfully well and have gotten excellent results. Where they have not, our law gives the state department adequate remedies.

Patrol Sections, Selection of Patrolmen and Salaries.—We believe in the patrol maintenance system. Patrol sections of proper length, whatever the character of the highway, should be placed in charge of a patrolman who is solely responsible to those above him for the condition of his section. We have established about 480 patrol sections on our 5000 miles of highway, varying in length from as little as six miles on very bad earth road stretches, to as much as 20 miles on some of the macadam truck patrol sections. We believe that the average patrol section should be not more than seven miles, if the road is an earth road in average condition. Sections may be longer or shorter than this, according to the character and condition of the road.

Patrolmen in Wisconsin were obtained through advertisements in local papers after the patrol sections were determined. Applicants were asked to appear at the county seat and were looked over and questioned by county authorities and a representative of the State Highway Department. Starting salaries were fixed at from $120 to $135 per month, and the patrolman is required to furnish a good team and a wagon. The county furnishes the remainder of the tools, consisting of a small four-wheeled road grader for two horses, a road planer, or road drag, or both; plow, shovels, picks, brush hooks, etc. Patrolmen are required to sign a contract and to give a bond for $500. No very great difficulty was encountered in obtaining patrolmen, except in certain localities where a large amount of war work was being done. After the selection of the patrolmen, county road schools were held at each county seat at which the division engineer and the county highway commissioner explained in detail the methods to be used in patrol maintenance. A pamphlet on patrol maintenance was also published by the commission, giving instruction for the gang and patrol maintenance of the various types of road.

Of the 560 patrolmen originally hired, 75 were discharged and replaced before the end of the season. It was necessary in many cases to raise the compensation, so that at the end of the season the scale was from $120 to $140 per month.

In 1919, unless conditions change, we expect to pay more, especially for the better patrolmen.

The patrolmen are engaged continuously during the maintenance season, which with us lasts about eight months. In the winter season we expect to use them a part of the time for winter hauling of surfacing materials and for snow removal, where the counties are forced to remove the snow owing to the failure of local units to do so. The patrolman's wagon is marked with the standard triangle and number, and he is required to wear a distinguishing badge, to display a flag when off the road during working hours, and to make daily and semi-monthly reports.

Experience with Patrolmen.—In general, the patrolmen have more than justified our expectations. At least 65 per cent of them have given excellent service. About 20 per cent are on the division line between good and poor, and about 15 per cent will not be with us next year. We have had a small percentage of sections which as a result of a combination of disasters have given us considerable worry. We believe that when a section threatens to become a continuous "hoodoo," the only thing to do is to take it in hand and devote the organization's time and money to it until it is brought up to standard. In 1918 we shall reduce the length of many of our patrol sections and thus increase the number of our patrolmen. This increase will probably be about 20 per cent and will cut the average length of our sections from 9 to 7.5 miles.

We are trying to make the patrolmen's job an attractive one, and are going to make a specialty of paying the better men more money than the poorer ones, so that they will realize that good services are appreciated. We hope to develop an esprit de corps by providing certificates of merit, banners to be displayed on especially well-maintained sections, and bonuses for consistently good work to the good patrolmen. We want to make the patrolman's job one well worth while, for upon him rests the success or failure of patrol maintenance.

Very few complaints have been received that the patrolmen were loafing. There has been some of this, inevitably, but between the county highway commissioner's getting around almost daily, our division engineer or division maintenance engineer's visiting each patrolman about once a week and reports from travelers and neighbors, we have kept a pretty close check on the patrolmen's activities, and believe that there has been comparatively little shirking.

In addition to the patrol maintenance, we organized each county for a certain amount of gang maintenance. This includes heavy road machine grading; scarifying, shaping and placing light resurfacings on old gravel and macadam roads; also surface treatments. Roughly, the expenditure for maintenance has been divided, one-half for patrol maintenance and one-half for gang maintenance. The expenditures in 1918 were at the rate of about $250 per mile. The cost of patrol maintenance per mile on earth and gravel roads averaged $125, the remainder being expended for gang maintenance or maintenance of the more expensive surfaces, such as macadam.

Wisconsin made an error in distributing the funds available for maintenance to the counties pro rata with the state trunk highway mileage lying in them. The distribution of maintenance funds should be made by the state department on the basis of maintenance needs. Type of road and amount of travel, of course, determine the funds which should be used, not any fixed factor of road mileage, population or valuation or even automobile ownership. Other states should not repeat our mistake.

Conclusions Deduced from the Year's Experience.—It may be interesting to summarize briefly some of the conclusions we have reached as a result of one year's state maintenance. These may not be final, but they seem well founded on our experience so far.

We find that earth roads of light clay or loam are easy to maintain either by dragging and planing or with the road grader, providing we have a rain about every 10 days. Continued dry spells are almost as troublesome as continuous wet spells, especially on light soils.

The two-horse, four-wheeled blade grader is the most effective tool for earth and road maintenance. The road planers are the second most effective, but must be built much stronger than usually shown or sold, if they are to stand the pounding of constant use. We are going to start an intensive campaign for applying a sand or gravel light surfacing, on earth roads which are sticky or slippery after rains. We have been astounded at the results from light (2-in. to 4-in.) sand and gravel coatings on heavy clay soils, if followed by patrol maintenance. This is probably the most valuable lesson we have gotten from this year's maintenance experience. We have learned that well maintained earth roads need very little crown. The flatter and wider an earth road the better, if it has good drainage and is kept constantly smooth. The same is true for all other types.

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*[illegible] Highway Con-

On sand roads, we find that marsh hay and straw are effective if covered with sand at the time of application, and that sand prolongs by much the life of these materials. Cedar bark and cedar shavings are the best temporary sand coverings. Our tar-hay experiment on sand was quite successful, but this method of sand maintenance is entirely too expensive, costing at least $700 per mile per year to maintain a good 16-ft. composition surface. We believe that the economical thing to do with sands is to cover them with good clay or gravel as rapidly as funds permit. Tar-hay, hay, straw and weeds wear out rapidly and are far more expensive in the long run than a clay or gravel permanent treatment under even very disadvantageous and expensive hauling conditions.

The roughest roads on the state trunk highway system have been the water-bound macadam roads which have been surface-treated in past years. It is probably theoretically possible to maintain a limestone macadam road with surface treatments, but with the instruments of maintenance in the way of man-power which we have to use in these days, effective results are very difficult to obtain. The untreated waterbound macadam roads maintained with light coatings of sand, pea gravel or stone screenings, or even with a road machine, have been more satisfactory than have the treated macadams that were not properly maintained from their construction. We expect as rapidly as possible to scarify all of our worn macadam roads, widen them to 16 or 18 ft. and cover them with a coating of 2 or 3 in. of fine gravel.

We have about given up the water-bound stone macadam road as too expensive to maintain. Some of the penetration macadams bound with tar or asphalt have given much better service than expected, and have shown themselves superior in maintenance possibilities to any water-bound structure we have built. This is another reversal of a former opinion.

We have found that the most satisfactory cheaply built roads to maintain are the gravel roads. We have scarified many miles of old gravel roads and at a cost of $200 or less per mile have produced a surface very satisfactory and easy to maintain. The more experience we have with gravel, the more convinced we are that it is the lowest cost surfaced road, both to build and maintain, and much superior to water-bound macadam. We believe that the particles of gravel in the top 4 in. of a gravel road should not be larger than 1 in., and we would crush even finer if it were not so expensive to produce fine crushed gravels. Gravel roads give the best and smoothest service without surface treatments. If it is necessary to treat them to eliminate dust use very light oils and don't try to build up a protective coat.

We have found trucks and tractors not generally satisfactory for patrol maintenance. Trucks give too much opportunity for "joy riding," are economical only when used for hauling, and then only when rapid loading and unloading facilities are available. Tractors give fair service, but to make them economical the sections must be so long that a part of the road lies undragged for too many hours after it gets in condition for dragging. It is a fact that with both the trucks and tractors if the patrolman starts as soon as a road is fit for dragging, on the long sections the road has become too dry before he completes the two round trips necessary. Furthermore, neither tractors nor trucks provide the ditch and shoulder maintenance that can be gotten with a team. We are distinctly going to discourage the use of both trucks and tractors in patrol maintenance except as supplements to team patrol, and stand by old Dobbin.

Summing up the maintenance results, we can say that on the state trunk highway system in Wisconsin, despite the fact that our construction has been cut to less than half of the normal, due to war conditions, the main roads in Wisconsin were never so good as they have been throughout this season. We estimate that in one year we have improved the average condition of the 5000 miles at least 50 per cent. Competent estimates are that in the one year the increased number of miles per hour which can be safely averaged by auto over the state trunk highways is seven. This improvement and this increased mileage per hour means much.

It is not safe to make broad statements, because conditions as to soils and availability of materials vary so much in various states. Nevertheless, we believe that any state can equal or surpass this record at an average cost of about $250 per mile per year. If more money can be made available the first few years, so much the better. We have learned to have the greatest respect, which we did not entertain heretofore, for the less expensive methods of maintenance and construction. In fact, 1918 has taught us all in Wisconsin more than we have learned in several preceding years of routine construction.

We feel distinctly confident that if one year has enabled us to obtain the results which have been produced, a succession of years will give us a passable highway system at an expense within our means. Maintenance will bridge over the gaps which there must be between our present practically unroaded condition and the ultimate system of adequate highways built to bear modern traffic, which all states are going to have as fast as these systems can be financed and built.

Probably the best commentary on the maintenance results of this year is the fact that at the November meetings of our county boards many of the counties adopted county trunk highway systems to be maintained in 1919 by the counties by the patrol system. It is probable that the total mileage on these county systems is half that on the state system, so that Wisconsin will have 7500 miles of patroled highways in 1919.

Labor Saving Machinery in Marquette County, Michigan, Road Work

In road surfacing operations in 1916 in Marquette County, Michigan, 17 men and 5 teams, including roller men, fireman and cook, were employed. The past year a maximum force of 8 men, including foreman and roller men and one team was employed, and yet approximately double the amount of stone on longer hauls was put down.

The machinery used on this work was as follows: One hand pump; a 6-HP. Fairbanks gas engine; a 250-gal. Morse centrifugal pump, both mounted on one set of skids and belt connected. The same apparatus was used for pumping water for sprinklers and pumping bitumen from tank cars into the tank wagons. A motor truck also was substituted for four teams. An endless belt conveyor of the grain type without buckets was used for unloading the stone cars. This took the place of six men while the spreading apparatus on the truck cut down the necessary spreading crew. The roller crew remained the same but because of better watering conditions one sprinkler with a team proved all that was necessary except on long hauls or in exceedingly dry weather. When water had to be pumped by hand two teams and two extra men were required for the same work. K. I. Sawyer is County Road Engineer.

The foregoing note is taken from a paper presented at the recent convention of the American Association of State Highway Officials by Frank F. Rogers, State Highway Commission of Michigan.

Amendment to Post Office Federal Appropriation Bill Provides $50,000,000 Additional for Federal Aid Roads.—The U. S. Senate committee on post offices and post roads on Jan. 27 adopted an amendment to post office appropriation bill, adding $50,000,000 to the amount to be expended in aiding the several states to build roads during the fiscal year 1919, and increasing by $75,000,000 the amount to be expended during each of the two fiscal years 1920 and 1921.

The Educational Campaign for the $60,000,000 Road Bond Issue in Illinois

Last November, the citizens of Illinois by a vote of [illegible] to [illegible] authorized a $60,000,000 bond issue for state highway improvement. The large majority is generally credited to the well planned educational campaign carried out for the purpose of presenting clearly to the people the merits of the proposition. The main features of this educational campaign are described by Mr. S. E. Bradt, State Superintendent of Highways, in a pamphlet issued by the Portland Cement Association.

Features of the Campaign.—At the time the bill was introduced in the legislature, the United States was not involved in the European conflict, but before it became a law war had been declared. Following the passage of the bill, the Illinois Highway Improvement Association commenced to outline its plan of campaign. The plan proposed for the improvement of this system of roads met with practically no opposition wherever it was understood, but the man who failed to have full information in regard to it was inclined to oppose this bond issue the same as others, fearing additional taxation. In this connection, attention is called to the fact that instead of requiring only a majority of the votes cast upon the proposition, the Constitution of Illinois required a majority of votes cast by men voting for members of the General Assembly, which meant practically a majority of all votes cast at the election. This feature, combined with the general opposition to bond issues which necessitate additional taxation, made necessary a vigorous campaign of information.

The war, however, had become the all absorbing topic. The people, with the exception of those particularly interested in road improvement who needed no convincing, would not take the time to attend good roads meetings. It therefore became necessary to formulate a different campaign from that ordinarily carried on. Instead of the projected road meetings attention was given to securing a place for speakers on the programs of all public gatherings. At these meetings, the plan was presented briefly and an endorsement requested and usually unanimously given. Before the closing month of the campaign the most formidable list of endorsements, both from organizations and prominent individuals, ever given to any project presented to the people of Illinois, had been obtained.

Forming of County and Precinct Organizations.—It was deemed essential also to carry on a local campaign in each community. For this purpose there was appointed a county campaign committee in each county. These committees consisted in the beginning of from three to five members who were permitted to make such additions to their number as they saw fit. Great care was used in forming these county committees by selecting people of standing in the community as well as those who were enthusiastic road advocates.

The county committees were requested to meet and elect a chairman, secretary, treasurer, and publicity manager and then proceed to organize the county by naming township chairmen, precinct and school district committeemen, and workers at the polls on election day. During the last few months of the campaign, fieldmen were sent out to visit the various county campaign committees and to assist them where necessary in completing their organizations to effectively carry on the campaign. Where it was found necessary, these fieldmen went to the counties several times before election day. The work done by these county organizations in a hand to hand manner is undoubtedly responsible in a large measure for the success of the bond issue.

Publicity Through Literature.—Another interesting feature of the campaign was the method of securing publicity. The Illinois Highway Improvement Association furnished to the county committees the necessary literature consisting of maps, booklets, circulars, folders, etc. These included a text-book covering the entire plan in detail to be used by those who wished to prepare themselves to talk both publicly and privately for the bond issue. A state map 15 in. by 28 in., showing the bond issue system of roads and giving essential details of the plan, was distributed; also three different circulars written by well known farmers; three circulars prepared by well known labor leaders; a circular covering the financial phase of the situation; and during the last 30 days of the campaign a folder appealing to automobilists was distributed through all the filing stations of the state. A small leaflet for use by manufacturers in the employes' pay envelope was another feature; and finally, a sample ballot for distribution on election day and badges to be worn by those favoring the proposition. Most of these circulars, folders, and leaflets were brief, yet contained the main facts regarding the proposition. Not fewer than 6,000,000 pieces of literature were distributed by the Illinois Highway Improvement Association mainly through the county organizations.

Newspaper Publicity.—Another thing that should be given special mention is the co-operation of the newspapers of the state in this campaign. All papers, including the metropolitan dailies, the country daily and weekly papers, the farm and trade papers, gave of their space freely. During the last six weeks of the campaign two full page sheets of publicity matter were sent out by the Illinois Highway Improvement Association. This was furnished in the form of "boiler plate" to those papers so desiring it, while to others the copy was given and set up in their own composing rooms. It is estimated that approximately 25,000 columns of printed matter pertaining to the bond issue were donated by the newspapers of the state.

Special Motion Picture Film.—Another interesting feature of the campaign was a two-reel film prepared and circulated by the Illinois Highway Improvement Association. This was entitled, "Through Illinois Over Unchanged Roads in a World of Change," and was furnished without expense to moving picture houses. It was used generally over the state in motion picture theaters and brought out unusually favorable comment. Ten sets of films were thus circulated.

Closing the Campaign.—During the last six weeks of the campaign, the association was handicapped by the launching of the Fourth Liberty Loan campaign which closed about three weeks before election, and also by the influenza epidemic. Practically all county committees had arranged for township and schoolhouse meetings either in the interest of the bond issue alone or in connection with political and other gatherings. The order issued by the State Board of Health prohibiting all public gatherings forced the making of a sudden change in the campaign from public meetings to newspaper and poster advertising. The Illinois Highway Improvement Association immediately printed and forwarded to the county campaign committees for circulation 50,000 half-sheet posters. In addition, the county committees were urged to use, especially in the larger centers of population, half page and page paid advertisements in their daily papers. Also a thorough organization of nonpartisan poll workers had been effected by the county campaign committees generally throughout each county. These workers were at the polls with the sample ballots, wearing bond issue badges and urging the people to vote for the road bond issue. This was supplemented by both the Republican and Democratic poll workers, who gave the proposition their hearty support. On the little ballot, with the road bond issue was the proposition of submitting the questions of the Constitutional Convention in which the women of the state were greatly interested. Because of this, many women workers were at the polling places supporting not only the constitutional convention proposition but also the good roads bond issue.

Effect of the War on the Campaign.—Shortly after the adjournment of the legislature much unfavorable comment was heard concerning the bond issue on the grounds that while we were engaged in this stupendous war we had no time to think of or discuss a good roads bond issue—that the entire matter should be postponed until some later date. The Governor with his usual foresight then came to the rescue by making a public statement to the effect that if the bond issues was approved by the people he would not issue the bonds or commence construction until the close of the war. In connection with this statement he called attention to the fact that economists predicted a period of depression following the war in which we would probably find labor plentiful and work scarce. In view of this probability, he urged the people to approve the bond issue in order that the state of Illinois might be prepared to do its share in providing employment for soldiers returning from the front and civilians released from war industries. This statement immediately relieved the situation and proved to have a decided influence on the minds of the people in favor of the bond issue.

Financing the Campaign.—The financing of the campaign was done entirely through voluntary contributions. The Illinois Highway Improvement Association, through its finance committee, raised sufficient funds to pay for all printed matter and the preparation of the public news sheets furnished to the press of the state; also to defray the general office expense, which was considerable. The local campaign expenses, including the payment for local newspaper advertising, were provided by the county campaign committees.

Public Works as Buffer Employment for Soldiers and War Workers

In his pamphlet, "Public Works or Public Charity," issued recently by the War Committee of the Union League Club of Chicago, Prof. H. G. Moulton, of the University of Chicago, estimates that during the next 12 months 5,000,000 or 6,000,000 workers will seek employment in this country. To meet this labor crisis, arising from the demobilization of troops and war workers, he suggests the providing of buffer employment by quasi-public enterprise, by the Federal Government, the state governments, and by municipalities. He considers that American cities perhaps afford the best opportunity for extensive construction projects during the coming months. Regarding this he states:

Many building projects were postponed during the war in consequence of the shortage of labor and building materials, and many of the cities now have funds in hand and are prepared to begin at once the delayed construction operations. Data before me from 13 typical middle western cities show expenditures of $27,000,000 which will be made in the near future. It is estimated that 48 per cent of this will go for labor. It has been reliably estimated that the total of public money annually spent in the United States on permanent improvements is about $600,000,000—about two-thirds of which is spent by the governments of cities. During the years 1917-18 about $300,000,000 of such work was postponed—mainly in the states and cities. If in the year 1919 we should spend this $300,000,000, plus the $600,000,000 normally devoted to new construction, and add to that another $300,000,000 as an insurance for the emergency, we would be able to employ on public works (Federal, state, and municipal) during the year 1919 about 400,000 men.

The carrying through at this time of a program of public works would result not merely in giving direct employment to 400,000 workmen; it would do much to start the hesitant wheels of industry everywhere. At the present moment the demands for the production of basic raw materials is at a low ebb owing to the sudden cessation of enormous war orders and the uncertainty as to the immediate future of private industry. Let the national Government, the state governments, and the municipalities engage in a comprehensive building program and the materials required will immediately create a strong demand for the production of iron and steel, and metals generally, of coal, lumber, cement, etc. The wages paid to the employes engaged in public works would at the same time place in their hands purchasing power with which they would go into the markets and demand the commodities which enter into ordinary consumption. Similarly, the wages paid to those engaged in the production of the raw materials required for the building operations would serve to create an additional demand for consumptive goods. The increase in demand thus becomes rapidly cumulative, and the foundations are laid for a period of great activity in all lines of industry.

Specification for Pitch Paint Coat Method of Constructing Creosoted Wood Block Pavement

At the 1918 convention of the American Wood Preservers' Association the Committee on Wood Block Paving submitted as a specification for information its report on bituminous paint coat construction and recommended that one more year of experience with this type of wood block pavement construction should be had before definitely adopting it as a standard method. In its report submitted at the convention last month the committee made a few slight changes in the specification. The specificaton* as recommended for adoption by this committee now reads as follows:

Base: On the sub-grade, properly prepared, shall be spread [illegible] base of the thickness [illegible]. The concrete shall consist of 1 part cement, [illegible] parts fine aggregate and [illegible] parts coarse aggregate mixed with sufficient water to produce a wet mixture that can be [illegible] floated. The surface of concrete shall be finished to an even surface by any approved method. The finished surface when tested by laying a metal shod straight edge at least 5 ft. long in direction parallel to curb line, shall show no variation greater than ¼ in. Projections greater than ¼ in. to be trimmed. Depressions to be flushed with mortar, consisting of 1 part cement to 3 parts sand of sufficient thickness to bring surface within the allowable limits specified.

Cement: Cement shall be Portland Cement conforming to the specification of the American Society for Testing Materials.

Fine Aggregate: Fine aggregate shall be clean, sharp sand.

Coarse Aggregate: Coarse aggregate shall consist of clean, sharp, tough, durable crushed rock or gravel, graded in size, free from vegetable or other deleterious matter. The size of the coarse aggregate shall be such as to pass a 1½ in. round opening and shall range from 1½ in. down, not more than 5 per cent passing a screen having 4 meshes per linear inch and no intermediate sizes shall be removed.

Pitch Paint Coat: On the thoroughly cleaned and dried concrete base shall be spread as thin a uniform coat of pitch as it is possible to apply, as hereinafter specified. It shall be heated to a temperature of not less than 250° F., and not more than 300° F., poured directly on concrete and spread smoothly while hot to a uniform thickness of not more than ⅛ in.

Laying Blocks: On the hardened pitch paint coat, thus prepared, the blocks shall be carefully set with the fiber of the wood vertical in straight parallel courses, leaving a space next to the curb 1 in. in width for the expansion joint.

The blocks shall be laid by setting them hand-tight. No joint shall be more than 3/16 in. in width. They may be driven together lightly every fourth course to keep the rows straight. Nothing but whole blocks shall be used, except in starting a course, or in such other cases as the purchaser may desire, and in no case shall the lap joint be less than 2 in. Closures shall be carefully cut and trimmed by experienced men. The angle of the course to the curb shall be fixed at the discretion of the purchaser. After blocks have been placed they may be rolled by a tandem roller, weighing between 4 and 7 tons.

Expansion Joints: Expansion joints 1 in. wide shall be provided next to and along the curb line, expansion joints being filled with pitch as hereinafter specified.

Filler: After rolling is completed the joints between the blocks shall be filled with a pitch filler as hereinafter specified. It shall preferably be done only when the temperature of the air is above 45° F.

The pitch shall be heated to a temperature of not less than 250° F., nor more than 300° F., pouring directly on the surface of the blocks, and by means of a hard rubber squeegee shall be squeegeed into the joints between the blocks. Care must be exercised that no surplus pitch is left on the surface of the blocks, and in no case shall there be a second application of pitch. After the filler has been thoroughly worked into the joints between the blocks the surface shall be completely covered to a depth of about ⅓ in., with clean, coarse, dry sand or slag screenings, which shall be left upon the pavement.

Coal Tar Pitch: The pitch used for the paint coat, expansion joints and filler, shall be obtained entirely from the distillation of coal tar and shall comply with the requirements specified on page [illegible] of the proceedings of the American Wood Preservers' Association.

*Where this specification is used it should be inserted in the specification printed in the 1917 proceedings of the American Wood Preservers' Association.

How to Cut a Strikeboard to a Circular Arc

The standard Specifications of the American Concrete Institute recommend that the surface of concrete highways be finished to a crown approximating to the arc of a circle and the height of the crown at the center of the highway above the edges of the pavement is recommended to be not more than 1/50 and not less than 1/100 of the width of the pavement. It is difficult for a carpenter or mechanic to lay out a curve of this kind which can be relied upon to give a correct curve. A method based upon a simple geometric proposition, which if properly followed will give an absolutely true curve, is described in The Concrete Highway Magazine.

If the [illegible] of the [illegible] upon which the strikeboard is to be cut is not absolutely straight, the lay-out can be made to a chalk line. Drive a stiff finishing nail at each of the points A and B, see Fig. 1, which will mark the width of the pavement. Find the mid-point between these points and mark on the board a line at right angle to the straight line A B and drive a nail at M, as far above the mid-point of the line A B as required by the cross section for the crown height at center.

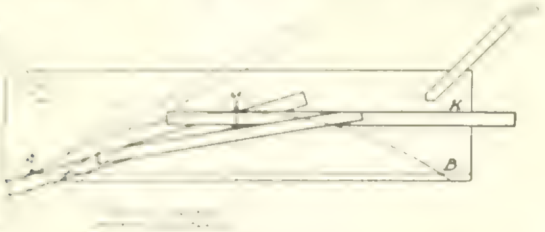


Fig. 1.

Take two light pieces of lumber which have straight edges (strips of cedar siding are good) and fasten them rigidly together so that they form the angle KMA. The line KM must be parallel to AB. Then if one side of this angle is held against the nail at M and one at A, the intersection will form a point on the desired curve. By shifting the angle the intersection may be moved from M to A and points on the curve marked as often as desired. By turning the angle frame over, the curve on the other half may be similarly marked.

Public Works and the Returned Soldier

Here is what I should want to do if I were City Manager: Get the Commission to announce that our town intends to see every bona fide resident safely through the crisis. No soldier returning from war shall be told that society has no use for him or that he must now go tramping from employer to employer vainly trying to sell his services. Neither must those who stayed home be displaced to make room for the soldier, since that merely doubles the amount of necessary adjustment without touching the problem.

Therefore our town will concentrate in this year the public work that ordinarily would be spread over last year and this year and next year and the year after, improving and beautifying and setting in order our municipal household in every sound and ultimately profitable way. What little extra it may cost to float a bond issue and buy materials now will be offset by the prevention of enlarged expenditures on crime, disorder, hospitals and police which are the inevitable accompaniments of hard times and industrial chaos.

We will push these public works to whatever point may be necessary to absorb the excess supply of local labor.—Richard S. Childs in a paper presented Nov. 7 at the convention of the city managers' association.

Kentucky Road School.—A short course in highway engineering will be held Feb. 24-28 at the University of Kentucky under the auspices of the college and the State Department of Public Roads.

Cost of Constructing Gravel Foundations for Roads

In estimating the cost of a gravel foundation it is necessary to consider: The purchase price of the gravel it is proposed to use; the cost of delivering the gravel on the work, and the cost of spreading and compacting. The first two of these factors are evidently dependent to a very great extent on local conditions, and their influence on the cost of a given foundation cannot be determined except by a study of the given conditions. The following data, from a Bulletin of Drainage Methods and Foundations for County Roads, issued last December by the U. S. Bureau of Public Roads, are intended to serve only as an aid in making the necessary study:

A cubic yard of loose gravel ordinarily weighs between 2700 and 3300 lb., the average weight being about 3000 lb.

Loose gravel will shrink from 12 to 15 per cent in volume when compacted in a road foundation. In determining the loose volume of gravel required for a given project it is customary to compute the compacted volume and add from 20 to 30 per cent to cover waste, shrinkage and loss in handling.

The average cost of loading pit gravel by hand into wagons is about 20 ct. per cubic yard. Where the amount of work to be done is sufficient to warrant the installation of a steam shovel or the construction of a special scaffold so that wheeled scrapers may be used for loading, the cost of this work usually may be reduced, the reduction sometimes amounting to 50 per cent or more.

The cost of screening gravel varies greatly according to the character of the pit-run material and the kind of screening equipment employed. Hand screening costs from 25 to 50 ct. per cubic yard, while with a properly arranged mechanical screen the cost should not often exceed 15 or 20 ct. per cubic yard.

The cost of hauling depends on the equipment used and the condition of the road over which the hauling is done. With teams at $5 per day and the roads such that two tons may be hauled at a load, the average cost is about 25 ct. per ton mile, or 37½ ct. per cubic-yard mile.

The cost of spreading gravel, on five road projects recently supervised by the Office of Public Roads and Rural Engineering, ranged from about 3 ct. to about 8 ct. per cubic yard. The average cost was about 6½ ct. per cubic yard and the average cost of labor was about 20 ct. per hour. The wagons used in all cases were built so that they dumped directly upon the subgrade and were designed to spread the material to a considerable extent while it was being dumped.

The cost of rolling the gravel on the above five projects ranged from slightly less than ½ ct. to about 1 ct. per square yard. The average cost was about 0.6 ct. per square yard. This included only the labor cost and if fuel for the roller and depreciation were considered the average cost probably would approximate 1½ or 2 ct. per square yard.

Scientific Training and Executive Ability

We have learned that real experience must take science as its handmaiden to accomplish real results. No longer is that vague thing executive ability regarded as of necessity divorced from knowledge and scientific training. You make professors of your universities heads of your great philanthropic trusts and your national executives; in Britain we make an ex-professor of a Canadian university minister of National Service and Local Government. You make engineers food controllers and we make them presidents of our railroads and civil lords of the Admiralty. This is a fundamental change, for much of our wrong-doing in the past has been due to suppression of the trained scientific mind in the formulating and practical working out of our policies. In no matter do we need more to get away from custom and clap-trap about uninformed executive ability, than in municipal government and housing, with all deference to the many able amateurs who have heretofore controlled our public affairs.—Thomas Adams, Town Planning Adviser, Canadian Commission of Conservation, in address at 7th National Conference on Housing.

Some Things the Road Contractor Often Overlooks

Until a short time ago overhead expense was something that the average business man thought he need not know anything about, and there are few lines of business that have not suffered at some time from the ravages of this unrecognized messenger of gloom.

When estimating on concrete highways, states William F. Hildeman, Concrete Road Contractor, in the January Concrete Highway Magazine, it is proper to give attention to unexpected costs with which every job is more or less burdened. Let's start at the beginning and work through. Perhaps we can find some of the oversights that are frequently responsible for our coming out at the small end of the horn when the job is finished.

With the contract in your pocket, bond filed to cover, have you figured the interest on cost of check and cost of bond?

You ship machinery somewhere near the starting point of the job and when you expect it to arrive your superintendent and a couple of your regular men are there waiting for it. Railroad fare, board and room, and freight bills start at this time.

The equipment arrives—some part is broken or damaged in transit. Another delay until either the local blacksmith can make the necessary repairs or new parts may be brought from somewhere in America—with cost of board and room and other expensive elements going on as usual.

Next is either a camping outfit or some means of conveyance to get men back and forth from the job. Oil, gasoline, tire, and many kinds of repair expenses are, among things, in order. A night watchman, a man at the pumping house to keep the water coming through the roller or mixer have to be considered.

Telephone bills are incurred daily to keep material coming. Few days of rainy weather are scattered here and there throughout the period of the job. Roads are muddy; demurrage puts a blot on the profit side of the ledger. Either these, or no material at all, and regular men of the crew drawing their salary in the meantime.

Just as you are getting a good start, something happens with some part of the mechanical equipment. Flues commence to leak, possibly because of the quality of water you had to use. As there is no chance to send the gang home, you start in to work on the shoulders. Progress is slow, however. for most concreting gangs do not like building road shoulders, and as the concrete laid will not permit use of a wheeler or scraper, you are up against it.

About this time the party owning a water hole, from which you are getting your supply, wants pay for the water with chances that he wants as much for it as you are expecting in profit on the job. Never use a farmer's well until you have made a written agreement covering its use, knowing whether or not it is going to cost you something and how much.

Then there are those numerous things that can be grouped in no other way than by calling them incidentals. They all show up on every job and they all cost money.

We have depreciation, too. Isn't it a fact that we fool ourselves on this very important question? There seems to be a very large difference of opinion among road builders as to the amount to be charged for depreciation of road-building machinery and this is one of the real reasons why many contractors lose out financially in concrete road building.

Another important item that must not be overlooked is interest on balance held over from fall to spring on incomplete jobs. This is a very important expense for a contractor with limited capital.

The foregoing are merely a few reminders. Nevertheless, they are sure to be on almost every job. Are you sure that every time you bid you give them proper consideration?

Cost of Subgrade Preparation in Road Construction

The cost of preparing the subgrade of a road to receive the foundation or road crust depends to a very considerable extent on the degree of care exercised in doing the rough grading, and to a less extent on the type of road crust or foundation which it is proposed to employ. The character of the soil composing the roadbed also may be an important consideration in estimating the cost of this work, especially if any considerable period of time elapses after the completion of the rough grading before the subgrade is prepared. Some soils remain loose indefinitely and are easily worked into proper shape, while others may become hard and compact in a very short time after being placed in a roadbed. In a recently issued bulletin of the U. S. Bureau of Public Roads on drainage methods and foundations for county roads the following examples of road improvement projects completed under the supervision of the Bureau of Roads are given to illustrate how the cost of subgrade preparation varies with the local conditions.

[illegible] No. 1.—A [illegible] road in Montgomery County, M[illegible]
[illegible]
Character of soil, stiff clay.
[illegible] finished.
Cost of preparing subgrade, [illegible] per [illegible].
Work done with pick and shovel.
Cost includes necessary rolling.

Example No. 2.—Several sections of gravel road in Leflore County, Miss.
Aggregate area surfaced, 189,535 sq. yd.
Character of soil, light loam.
[illegible]
Cost of preparing subgrade, approximately, 1.4 ct. per square yard.
Work done with road grader and a limited [illegible] required.
Cost includes necessary rolling.

Example No. 3—A gravel road in Bexar County, Tex.
Area surfaced, [illegible] sq. yd.
Work consisted of scarifying and reshaping an old gravel road, and was done by means of a roller with scarifier and road grader.
Cost of preparing subgrade, 3.8 ct. per square yard.
Cost includes picking out large stones that were turned up in scarifying, as well as all necessary rollings.

Example No. 4.—A concrete road in Licking and Muskingum Counties, Ohio.
Length of road, 24 miles; width of concrete surface, 16 ft.; character of soil, stiff clay. The rough grading was done with steam-shovel equipment and scrapers, and the work was in progress during 1914 and 1915. During 1914 the subgrade was prepared almost immediately after the rough grading was completed, and the average cost of its preparation was approximately 3 ct. per square yard. During 1915 the rough grading was completed several months in advance of the subgrade, and the average cost of preparing the subgrade was approximately 7½ ct. per square yard. This large difference in cost is attributable partly to the fact that several washing rains occurred between the time of completing the rough grading and the time of preparing the subgrade, and the work charged to subgrade preparations really included a considerable amount of rough grading made necessary by [illegible] of the roadbed.

Arkansas Proposes Construction of 3,115 miles of Road in 1919-20.—The State Highway Commission of Arkansas in the last annual report states that during the period 1917-18 surveys were made for 3,461 miles of road to cost about $18,000,000. The department constructed or had under construction under the improvement district plan 559 miles of roads at an approximate cost of $5,173,237.72, to which the State and Federal governments are contributing $829,519.48. In addition I constructed or had under construction approximately 400 miles of graded roads at a cost of $494,276.10, the State and counties each bearing half of the expenses. It also constructed or has under construction 50 miles of road, the cost being $179,171.84. Of this amount the State is contributing $76,000 and the Federal government $103,171.84. The total number of miles of all kinds of roads constructed or now under construction for 1917-18 was 1,009 miles, the total approximated cost of which is $5,846,685.66.

During the next biennial period of 1919-20, it is expected that 3,115.22 miles of road will be improved, at an approximate [illegible]

Experience With Bituminous Paint Coat Method of Laying Wood Block Pavement

[illegible] wood block pavement, as a number of cities having this form of construction failed to answer the question [illegible] consideration of first cost, is, in your opinion this type of construction to be preferred?" 5.19 per cent of the replies were [illegible] per cent expressed no opinion. Other points covered in the questionnaire in- [illegible]

[illegible] for painting concrete?

[illegible]

The answers are summarized as follows:

[illegible] 6.48 per cent don't answer.

(b) 0.00 per cent no [illegible] answer.

[illegible] 6.58 per cent don't answer.

[illegible]

that these disadvantages can be overcome.

[illegible]

Answers vary from 130° to 145°.

Wisconsin Highway Commission Publishes Map for General Public Use in Touring.—The Wisconsin Highway Commission adopted the innovation last season of publishing a road map on a scale of 1 in. equals 16 miles for general public use in touring. In addition to showing the numbered and marked state trunk highway system and the principal secondary roads, the points of historic and scenic interest and state institutions are also located and numbered in the map. Accompanying the map was a little booklet on Wisconsin giving her history, an index to historic, scenic, manufacturing and state property features located on the map, some record of the state's agricultural and manufacturing resources, and other material of interest. These maps were sold for 10 ct. each. After the first edition, the cost of which included about $350 for the plates and set-up, succeeding editions cost, addressed ready for mailing, about 7 ct. each, including 1 ct. for postage. About 20,000 were sold in 1918. The Commission expects a larger circulation in future years.

Indiana State Highway Law Valid.—The Supreme Court of Indiana on Jan. 10 handed down a decision upholding the validity of the law creating a state highway commission. The commisson was created by a legislative act of 1917, but shortly after it had effected its organization suit was brought by a taxpayer to enjoin the enforcement of the law and the issuance of bonds under it.

Cost of Quarrying and Crushing Limestone for a Road Improvement

The following data are for a limestone quarry in Loudon County, Tennessee, operated under the supervision of the U. S. Bureau of Roads in connection with a single road improvement. The quarry had been faced up, but required heavy stripping and the presence of numerous clay seams made drilling and blasting expensive. The stone is a dark blue, tough limestone, very similar in appearance to Knoxville dolomite. The depth of quarry face was from 12 to 18 ft. Blasting was done with 40 per cent dynamite, fired by means of batteries, and the rock was hauled to the charging platform in dump carts. A 25 H. P. engine and a No. 4½ crusher were used. The record output was 183¾ cu. yd. in one day of 14 hours. The bins were of 70 cu. yd. capacity, with three sub-divisions. The total amount of stone quarried and crushed was 4,932.3 cu. ft. The scale of wages was:

[illegible] per day	$4.50
[illegible] per day	2.00
Quarry foreman, per hour	.20
[illegible] per hour	.17½
[illegible] per hour	.20
[illegible], per hour	.17½
[illegible] per hour	.25
Powder man, per hour...	.16
Unskilled labor, per hour	.15
[illegible]	.05
Water boy, per hour	.07½
[illegible] per hour	.25

The items of cost were:

		Per cu. yd.
Labor:		
Superintendence	$ 128	$0.026
Stripping	219	.044
Drilling and blasting	413	.084
[illegible]	798	.162
Hauling to and charging crusher	1,306	.265
[illegible]	325	.066
Repairs to [illegible]	48	.010
[illegible] steel and small tool	211	.043
Total labor		$0.700
Materials:		
Coal	90	.018
Oil	11	.003
Dynamite, caps and fuse	261	.053
[illegible]	50	.010
[illegible]	65	.013
Total materials		$0.097
Finance:		
Interest on investment, depreciation, etc.	476	.096
Grand total, cost of quarrying and crushing	$4,398	$0.893

The recently issued U. S. Bureau of Public Roads, Bulletin No. 724, "Drainage Methods and Foundations for Country Roads," from which the above note is taken, states that the cost of quarrying and crushing will average at least 25 per cent higher for trap or granite than for limestone where the quarry conditions are similar. The Bulletin states that nine small trap and granite quarries in the state of Maine, operated under the supervision of the Bureau of Public Roads, showed a total average cost for crushing and quarrying of about $1.25 per cu. yd. The total quantity of crushed stone taken from the nine quarries was about 55,000 cu. yd.

Dunn Wire-Cut-Lug Brick Patents Sustained.—The U. S. Circuit Court of Appeals of the Sixth District has rendered a decision for the Dunn Wire-Cut-Lug Brick Co., Conneaut, O., in its suit against Joseph Nicholson et al. of Toronto, O., for infringement of patent on wire-cut-lug paving brick. The court affirmed the validity of the Dunn patent, declaring it basic, and requiring a discontinuance of the manufacture by the defendant and an accounting by him. The suit grew out of the manufacture and sale by the defendant of wire-cut brick having lugs cut by a knife instead of wires. The court held that the Dunn brick was a new and useful invention; that its general use aided in establishing its character; that it was an improvement on other wire-cut brick and was produced by simple means; that the invention was protected by a basic patent, and that the method of cutting the lugs made no difference, since whether the cutting was done by wire or knife or saw the methods were equivalent, and the Dunn company was entitled to protection.

Wind Aids in Constructing Sand Roads in New Mexico

A radical departure from old methods of building roads across extensive stretches of sand has been employed successfully in the construction of some 80 miles of highway in New Mexico. The method, in brief, is to make a cut in the sand to the underlying clay and then let the wind widen this cut. The method was developed by D. W. Jones, District Highway Superintendent of Curry, De Boca, Roosevelt and Guadalupe Counties, New Mexico, and was described by him in the January Highway Magazine.

First Stage of Construction: Sand Excavated to Hard Pan Ready for Wind Action.

The first highway constructed by this method was the Delphos Road in Roosevelt County. The route ran through a sand bed 9 miles long, 7 miles of which consisted of sand more than 30 in. deep with pockets of unknown depth. A state road outfit in charge of Mr. Jones handled the work The right of way was cleared of weeds and grass and the sand excavated down to hard pan. Fresnoes were used for moving the sand, which was deposited in spoil banks, located as shown in the sketch. The width of the cut at the bottom was about 12 ft. A narrow strip of clay road between high walls of loose sand was constructed, and left to action of the wind. The spring and fall winds swept away the sand remaining on the clay surface and widened the highway from its original width of 12 ft. to 35 ft. for the entire length of 9 miles.

The surface of the clay was very irregular and there were sand pockets ranging from 30 in. to 5 ft. in depth. This surface was not graded off until the waste piles had disappeared and the widening of the road by wind scouring had taken place. If the pockets were less than 30 in. deep they were left to the action of the wind and the wheels of vehicles. If they were more than 30 in. deep clay was hauled in and used to fill them.

The Delphos Road was constructed in 1915. The illustration is made from a photograph taken last October, and shows the eroded width of the sand on that date. The two stakes and the cross bar show the exact width (omitting the side slopes) and depth of the original excavation through the sand. The road cost less than $500 per mile, which figures includes some betterment work done during the following year. The maintenance cost in 1918 was only about 20 per cent of the cost of maintaining the adjoining Clovis-Portales Roads "plated" road, the original cost of which was more than $2,000 per mile.

The results obtained on the Delphos Road were so successful that this method was adopted for a dozen different sand beds in eight counties of the state. After the Delphos job the others followed in rapid succession. The most important are: The Clovis-Melrose sand bed, 7 miles long; the Kenna-Chaves County sand bed, 6.3 miles long; the Fort Sumner-Ricard sands, 10 miles; the Evanola-Yeso sand, 5 miles; the Thompson-Near Road, 9 miles; the Elida-Jenkins Road, 10 miles; the Portales-Loving Road and the Alamorgordo-Newman (E. Paso) Road. The latter two had more than 30 miles of sand beds, sand hills and sand dunes and other complications of this material. All these roads are opened today and in almost every instance just where they were the worst before treatment they are now the best.

Condition of Delphos Road Three Years After Construction.

Example of Effect of Proposed Increase in Freight Rates on Road Building

At a hearing at Chicago on Jan. 30 before the Central District Freight Traffic Committee of the Federal Railroad Association some interesting facts were brought out regarding the effect of the proposed increase in freight rates on broken stone, sand, gravel, cement and slag on highway construction. J. H. Bateman, Assistant Highway Commissioner of Michigan, stated that in the construction last year of the Detroit-Monroe road, the freight on the sand and gravel cost $2,400 per mile before June when the cost was increased to $3,200. With the proposed increase the cost would have been $5,200 per mile.

S. E. Bradt, State Highway Commissioner of Illinois, gave the following concrete examples:

"We will ship a ton from Janesville to Park Ridge, a distance of 98 miles. The price was 30 ct. until last June. Then the cost was raised to 50 ct., and now it is proposed to raise it to 95 ct. You can figure out how much that means in road construction when you estimate that 6,000 tons must be used to each mile. With the increase in rates last June the cost of the Illinois road program was raised from $60,000,000 to $64,000,000. This proposed raise adds on at least $4,000,000 more. Take a ton from Joliet to Springfield, 148 miles. It cost 53 ct. until June, then 70 ct., and now it is proposed to make it $1.20. Another illustration is from Racine to Evanston, 52 miles. The increase was from 40 to 60 ct. last June, and the proposal is for 85. The raise from Joliet to Pontiac, 55 miles, is from 47 ct. to 70 ct., and now to 85 ct."

Machine Grading of Roads in Pottawatamie County, Kansas.—Road grading by machinery is being done in Pottawatamie County, Kansas, at an average cost of $55.13 per mile, according to Kansas Highways. This figure includes labor, gasoline, oil, repairs, upkeep of machinery, 6 per cent on investment and 20 per cent depreciation.

Effect of Soil and Grade Conditions on Erosion of Road Ditches

Observations have been made by engineers of the U. S. Bureau of Public Roads with a view to determining just how the erosion of side ditches actually is affected by different conditions of soil and grade. The results of these observations are summarized in a Bulletin, "Drainage Methods and Foundations for County Roads," issued [illegible]

[illegible] in Maryland, [illegible] and North Carolina, and the data, so far [illegible] The conclusions [illegible] stated briefly as follows:

Except where the soil is sandy, the run-off, so far as the [illegible] should be assumed as 100 per cent of the rainfall.

For sandy soils the run-off varies considerably. Where the soil is as much as 3 or 4 ft. in depth and the grade does not exceed 5 or 6 per cent, it appears that the surface run-off may usually be entirely neglected. For less depths of sandy soil the run-off may for present purposes be assumed as inversely proportional to the depth. This does not apply to soils consisting of very fine sand with a large percentage of silt, as such soils may be almost impervious to water and always erode very easily.

The power of soils to resist erosion is much less when the ditch is first constructed than later. This is true especially where vegetation is allowed to grow in the ditches.

Although the velocity of flow is independent of the length of ditch, the length affects the quantity of water passing any given point, and consequently affects the amount of erosion. Further, the tendency to erode on the steep section of a ditch, however short, will be practically the same as if the steep grade prevailed throughout the length drained.

It is theoretically possible to construct an earth side ditch of such cross section as to carry any given amount of water on any given grade without erosion. But the impracticability of widening the ditch indefinitely and the difficulty of maintaining a wide flat-bottomed ditch necessary to produce this result in practice usually serve to place a rather low limit on the capacity.

Where ditches of ordinary cross section are employed, the most satisfactory way to prevent erosion is to provide outlets for the water at proper intervals, to be determined in the manner already discussed.

Where for any reason outlets for the ditches can not be provided at proper intervals it usually is much more satisfactory to provide a paved gutter than to attempt to widen the ditch beyond the limits already described as conforming to good practice. The main reason for this is that a wide ditch, though properly designed and constructed, easily may become partially obstructed, so that the channel is effectively narrowed and erosion results. Once started this may increase very rapidly.

Side ditches may be protected to some extent from erosion by means of "bars," "breakers," or "drops" constructed across the ditch at such intervals that the slope from the bottom of one breaker to the top of the next one below does not exceed what is allowable for the soil and maximum flow of water involved. Such breakers frequently have been constructed of wood and sometimes of stone or concrete. It should be noted that where drops are used much difficulty is experienced sometimes in preventing the water from finding its way around their ends and cutting into the shoulders or banks.

Where doubt exists as to the necessity for employing a paved gutter it frequently is permissible to withhold decision until time can demonstrate whether or not the side ditch is adequate. This is true especially where the gutter would be made of different material from the road crust, and constructed at a different time or by a different force of laborers.

The maintenance of side ditches consists in keeping them free from obstructions, and in reshaping them whenever this is desirable in order to prevent erosion. While a limited amount of vegetation may be advantageous to ditches on steep grades, it should not be such as to interfere seriously with the flow of water in the ditch. Where drops are employed should receive frequent attention to see that they are not being undermined and that the water is not cutting around them. The design of drops sometimes calls for the use of brush, logs, saplings, cut stakes, etc., as these often are the only inexpensive local materials available in rural sections. While such designs, if carefully considered, may produce drops effective for a considerable period, their use is not recommended because of the great danger that the drop will break up under stress of unusual conditions and the floating parts seriously obstruct the ditch.

The following examples have been selected from notes regarding some of the existing side ditches which have been observed:

Example No. 1.—Side ditch on Rock Point road, Charles County, Md.:
- Age of road, 1½ years.
- Original shape of ditch, flat V.
- Width of roadway, 24 ft.
- Width of gravel surface, 1[illegible] ft.
- Average width drained by side ditch, including slope, 25 ft.
- Character of soil, very light clay.
- Slope of ditch (grade), 2 per cent.
- Length from summit to where erosion begins, 100 ft.
- Ditch empties into cross drain at 500 ft.

Example No. 2.—Same road and same conditions as example No. 1 except slope of ditch is 3 per cent.
- Length from summit to where erosion begins, 200 ft.
- Ditch maintained with considerable difficulty below the 200-ft. point by means of wooden breakers.

Example No. 3.—Side ditch on Owings-Prince Frederick road, Calvert County, Md.:
- Age of road, 1 year.
- Original shape of ditch, flat V.
- Width of roadway, 23 ft.
- Sandy-clay surface.
- Average width drained by side ditch including slope, 22½ ft.
- Character of soil, very light clay with small percentage of fine sand.
- Slope of ditch (grade), 6 per cent.
- Length from summit to where erosion begins, 100 ft.
- At 300 ft. the ditch has eroded 1 ft. below the original section, and below 550 ft. it is maintained with great difficulty by means of wooden breakers. Below 650 ft., in fact, the entire road has been washed out at least twice, notwithstanding the breakers.

Example No. 4.—Same road as No. 3:
- Original shape of ditch, flat V.
- Width of roadway, 24 ft.
- Sand-clay surface.
- Average width drained by side ditch, including slope, 25 ft.
- Character of soil, mixture of light clay and fine sand.
- Slope of ditch (grade), 6 per cent.
- Length from summit to where erosion begins, 150 ft.
- Below 200 ft. it has been necessary to employ breakers, and below 400 ft. the breakers have been washed out on several occasions and the ditch has become dangerous to traffic.

Example No. 5.—Same road and same conditions as No. 4 except width drained by side ditch, 13 ft.:
- Slope of ditch (grade), 1½ per cent.
- Length, 600 ft., no erosion.

Example No. 6.—Washington-Baltimore road:
- Age of road, 5 years.
- Original shape of ditch, wide flat V
- Width of roadway, 27 ft.
- 16-ft. bituminous macadam surface.
- Average width drained by side ditch, 16 ft.
- Character of soil, sandy clay with considerable gravel.
- Slope of ditch (grade), 4 per cent.
- Total length of ditch, 900 ft.
- Below 800-ft. point the ditch has eroded slightly, but maintenance is very light

Example No. 7.—Washington-Atlanta highway in North Carolina:
- Age of road, over 5 years.
- Original shape of ditch, irregular, with average bottom width of about 1 ft.
- Width of roadway, 24 ft.

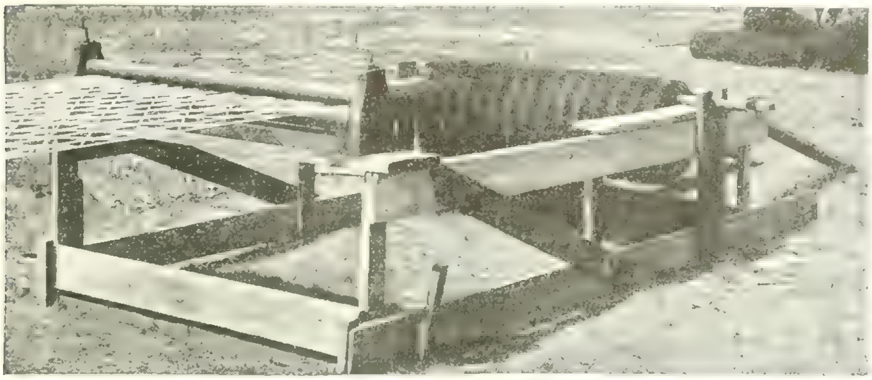
Earth road
Average width drained [illegible]
Character of soil, clay loam
Slope of ditch (graded), 2½ per cent
Length from summit to where erosion begins, [illegible]
Water turned off at 1,100 ft.

Example No. 8.—Same road and same conditions as No. 7, [illegible] slope of ditch, 4 per cent:
Length from summit to where erosion begins, 500 ft.
Ditch becomes dangerous to traffic below 600 ft.

Example No. 9.—Same road and same conditions as No. 8, [illegible] soil is a very stiff clay and slope of ditch [illegible] per cent:
Length from summit to where erosion begins, 500 ft.
Difficult to maintain ditch below 600 ft.; water turned [illegible] about 700 ft.

Simple Device for Straightening Mesh Reinforcement

The accompanying illustration from the Concrete Highway Magazine shows a simple and inexpensive device developed by the American Steel and Wire Co. for taking the roll out of mesh reinforcement. This device consists essentially of three pipe rolls with the necessary end housings and a channel iron base, the entire device weighing approximately 200 pounds. By manipulating set screws, the top pipe roll is raised or lowered until in the position required to exert the force necessary to straighten the fabric. Fabric is pulled through by man or horse power and cut to proper length by using hand nippers. The set of rolls, properly mounted, is attached to a bench of suitable height, which may be of crude construction. The weight of the entire device, including the bench, is such that it can easily be moved.


Device for Straightening Wire Mesh Reinforcement.

To Promote City Manager Plan

The constantly increasing interest in the commission-manager plan of city government has created a very definite demand for information, for aid in charter drafting, publicity methods and conducting of non-partisan campaigns. The City Managers' Association has felt this demand more keenly, perhaps, than any other one organization and the flood of inquiries reaching the desk of the Association's secretary emphasizes the urgent need of real service, organized and equipped to answer the scores of appeals.

To solve the problem, Harrison Gray Otis, recently reelected secretary of the City Managers' Association, has resigned his position as city manager at Auburn, Me., and has tied up with the American City Bureau, Tribune Bldg., New York City, which is already in the field of organization service. Lucius E. Wilson, who introduced the manager plan into Dayton, Ohio, and played a leading part in the successful charter campaign in that city, is at the head of the Bureau's field staff. The addition of Professor A. R. Hatton of Western Reserve University, the charter expert, and affiliated with the Short Ballot Organization and the National Municipal League, and of Mr. Otis, who, in addition to his office of secretary of the City Managers' Association is a member of the Advisory Board of the National Municipal Review, completes a trio of well qualified men as [illegible] with the large staff of the Bureau [illegible] available to assist as occasion requires.

The scope of the Bureau's activities will expand as the demand increases. The furnishing of public speakers, of charter drafters and publicity men, and the actual conduct of election campaigns are among the first steps. A "clearing house" for city managers will be developed in an effort to help cities secure trained executives.

The City Managers' Association will remain unchanged as to purpose and organization, being purely professional in character. It will continue to publish its year book and Association bulletin. Mr. Otis will serve the remainder of his term as executive secretary and the New York office of the City Managers' Association will hereafter be located in the Tribune building.

Massachusetts Has Special Committee to Forward Public Works and Civil Construction

Calvin Coolidge, Governor of Massachusetts, who with the Governors of the other states recently received from Secretary of Labor Wilson a request to stimulate interest in public works and civil construction, has announced the appointment of a special committee composed of representatives of labor and capital to forward this purpose.

Governor Coolidge has, in addition, issued an inspiring statement to the people of Massachusetts advising them that Massachusetts does not intend to be the "sport of chance," but the "master of of her destiny."

The Governor argues that the return to normal business life will not be accomplished by worrying over what may happen, but can only be accomplished by doing the tasks at hand. His statement is a gospel of courage and optimism not only for the people of Massachusetts but for the country. The substance of his message follows:

> [illegible] whether they will continue their activities as usual or wait to see if there is a decline in prices. No doubt there will be a decline in some directions. The public question now is how best [illegible] gradual decline would be preferable to a perpendicular fall in prices. It should be remembered that prices of labor and materials are all relative. When once adjusted the amount is not of great importance. There are two things to do. One is to wait; the other is to go on with business activity. If everybody waits there no doubt will be a perpendicular fall with attending want, distress and calamity. If people will go ahead with business, while there may be a gradual decline, it can be borne with the least inconvenience.
>
> I realize that business is and ought to be conducted for profit Still, there is not only the duty, but the expediency of keeping the working force, the organization, in dull times. We have all worked together to win the war. Let us all work together to enjoy the blessings of peace. The working people of Massachu- [illegible] must be maintained.
>
> Instead of being the sport of chance, Massachusetts ought to be the master of destiny. Instead of waiting, we should act. [illegible] merchandise. There ought to be no lack of a disposition to act, no lack of enterprise.
>
> The question is where to begin. A committee working with our board of labor and industries suggests the revival of building. This industry has been at a standstill for the past two years. It is in its nature basic. A contract for any kind of building at once makes the opportunity for other contracts for steel, cement, bricks, lumber, plumbing, steam heating, electrical equipment, and all other materials required in construction. This would mean the employment of large numbers of people in various factories manufacturng these materials.
>
> In this the various agencies of government ought to take the lead. It is therefore urged that all the departments in the com-

[illegible]

Road Machine with Floating Wings

A road machine that operates on the endless belt principle is illustrated. The machine is provided with two [illegible] which carry a series of steel slats riveted to the chain belting and traveling toward the center of the road at a reasonably high rate of speed. These drags overlap, thus permitting the conveying of material from the sides [illegible] to the center. The wings can be raised to a vertical position to permit teams to pass or to provide clearance in going over bridges. They also are adjustable for different widths of road bed. The machine is equipped with a 60-HP. motor which furnishes power for traction and for operating the drags. In a trial demonstration it is stated that the machine graded up 1 mile of 30-ft. road in [illegible] hours, [illegible] gal. of kerosene and 1 quart of lubricating oil in the work. The machine is manufactured by the Reschke Machine Works Co., Wichita, Kan.

Road Machine With One Wing Raised.

Chicago Draftmen's Union Has Over 700 Members

At the regular semi-monthly meeting of the Draftsmen and Designers' Union, Local 14, Chicago, on Feb. 1, 122 new members were initiated, making the total membership over 700. Officers for the ensuing year were installed by Mr. John Fitzpatrick, President of the Chicago Federation of Labor, who also delivered an interesting talk on the value of organization among technical men. The officers are: M. J. Brown, President; C. H. Monger, Vice President; R. Matthei, Treasurer; E. Hemmer, Recording Secretary; W. Callahan, Sergeant-at-Arms, and H. C. Brodman, Business Manager, 4954 West End Ave., Chicago.

Personals

Capt. C. R. Twiss has resumed his duties as city engineer of [illegible] after [illegible] months' service for the War Department.

William A. Stickel has returned to his duties as assistant [illegible] County, New Jersey. Mr. Stickel [illegible]

Prof. Myron Creese, of the engineering department of the [illegible] College at [illegible], has resumed his duties at the [illegible] after [illegible] service in the army.

Thomas Waters, [illegible] avenue, Indianapolis, Ind., has been appointed superintendent of street cleaning to fill the [illegible] caused by the resignation of Charles R. Gill.

John S. Crowns has been appointed chairman of the highways [illegible] committee of the Council of National Defense, to succeed [illegible], who has returned to his private business.

Bert G. Dinges, for a number of years manager for the [illegible] Company, at Spokane, has entered the general road contracting business with headquarters in Spokane.

Herbert C. Hoover, national food administrator, was awarded [illegible] tablet by the Western Society of Engineers. The tablet is awarded annually to the engineer who has rendered the greatest service to humanity within the year.

H. C. Shinn, of Trenton, N. J., has been appointed by the State Highway Commission supervisor of convict labor in the [illegible] department. Mr. Shinn was assistant engineer in charge of the central division of the department.

F. E. Bonner, assistant engineer for the forest service with headquarters at Washington has been detailed to act as district engineer for the forest service pending the appointment of a successor to R. E. Pratt, who died several weeks ago.

John R. Malang, of Joplin, Mo., has been appointed by the State Highway Board as secretary to fill the vacancy occasioned by the resignation of A. C. McKibbon, who held that position ex-officio during the time he was member of the Highway Board.

Z. A. Kauffman has been elected president of the Colorado Society of Engineers. The other officers are: Vice president, J. E. Maloney; secretary-treasurer, C. B. Daniels. Board of directors: A. Lincoln Fellows, Z. E. Wagner, C. S. Booth and C. M. Lightburne.

Horace H. Hull, city engineer of Memphis, Tenn., has been elected president of the Engineers' Club of Memphis. The other officers are: E. H. Bowser, timber expert of the Illinois Central Railroad, vice president; D. C. Miller, chief clerk in the city engineer's office, secretary-treasurer; D. M. Crawford, A. H. Lanham, and A. D. McWhorter, directors.

L. H. Hawblithe, Toledo, O., has been elected president of the Ohio Macadam Association, and **A. B. Sandles**, Columbus, O., has been elected secretary. The new trustees are: Allen Patterson, Lima; W. H. Hoagland, Columbus; Mr. Hawblithe, L. A. Peeghley, Youngstown; E. E. Evans, Toledo; A. A. Hall, Piqua; J. A. Moore, Bellevue; E. T. Paul, L. Lewisbrunist, F. Pogue, Findlay; J. J. Nichal, Toledo; W. D. Robinson, Toledo; J. A. McCall, Findlay.

Harvey S. Owen, formerly engineer of construction and principal assistant engineer to the chief engineer of construction, department of the president, St. Louis Board of Public Service, has been added to the staff of the Lime Association, Washington, D. C., as western district engineer of the Construction Bureau, with headquarters at 4906 Forest Park Blvd., St. Louis, Mo. Mr. Owen has had considerable experience in heavy construction and has spent the last several years in a study and promotion of diversified concrete usage, as well as expert inspection service on concrete highway construction in the middle west.

Obituaries

Charles A. Medicus, a contractor of Youngstown, O., died Jan. 19, aged 38.

Howard C. Whitman, engineer and contractor, Sacramento, Cal., died Jan. 18, aged 38.

Burt Ramsey, an engineer connected with the State Highway Department, died at his home in Midland, Tex., Jan. 14.

Cyrus T. Rayner, Jr., chief engineer of the Orleans Parish Levee Board, of New Orleans, La., died Jan. 19, aged 39.

F. M. Stanton, district plant engineer, in charge of plant construction in the Southern District, United States Shipping Board, with headquarters in Jacksonville, Fla., died Jan. 24, aged 40.

Rollac Carpenter, professor of the experimental engineer at Correll University since 1895, died Jan. 19. Prof. Carpenter, who was born in Orion, Mich., in 1852, had active charge of many large engineering construction projects and was the author of several works on engineering. He directed the installation of the high pressure fire system of Baltimore in 1911 and installed a high presure pumping system in New York in 1912. He was judge of machinery and transportation at the Chicago exposition in 1893, the Buffalo exposition in 1901 and the Jamestown exposition in 1907.

Industrial Notes

The Kentucky Wagon Manufacturing Co., Louisville, Ky., has purchased the Dixie Motor Car Co. This purchase gives the Kentucky Wagon Manufacturing Co. a complete line of passenger and commercial vehicles, as for a number of years it has been manufacturing Old Hickory motor trucks.

The Holt Manufacturing Co., Peoria, Ill., announces the appointment of Sutherland G. Taylor, Jr., as export Manager. Mr. Taylor assumed his duties at the Peoria plant on Jan. 1. For several years Mr. Taylor was vice president and New York manager of Cyrus Robinson & Co., engineers and exporters of New York and London. Mr. Taylor has within a month received his discharge from the United States Army, where as a lieutenant of ordnance he served as assistant to Major Carlisle, chief of the Motor Equipment Section, Procurement Division.

Trade Publications

The A. S. Aloe Co. of St. Louis, Mo., has issued recently a new supplement catalog which is of considerable interest. It describes and illustrates engineering, drawing and drafting supplies—all items listed in the booklet being articles which the Aloe Co. carry in stock. The logical arrangement and handy reference form in which the catalog is compiled makes it a reference book of value to the busy engineer and draftsman.

Waterworks and Hydraulics Monthly Issue

ENGINEERING AND CONTRACTING

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice. and the fourth is our annual "New Equipment Issue." The *articles* in the first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering and contracting field. The *articles* in the first and last issues of each month (1st and 4th Wednesdays) completely cover county engineering and highway engineering and contracting. The *articles* in the third and last issues of each month (3rd and 4th Wednesdays) completely cover steam and electric railway location, design and construction. See the "mast head" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power

Railways and Govt. Works—3rd Wednesday
(a) Excavation and Dredging (c) Harbors and Docks
(b) Rivers and Canals (d) Railway Construction

Buildings and Structures—4th Wednesday
(a) Buildings (c) Ship Construction
(b) Bridges (d) Miscellaneous Structures

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What Limit Should Be Put Upon Municipal Bond Issues?

Municipalities are usually prohibited by law from issuing bonds in excess of 2 per cent of the actual value of the taxable property. If railway companies had been thus limited there would have been no such development of railway systems as America now enjoys. More than half the money invested in railways has been raised through the sale of bonds.

In the case of a revenue-earning plant, like a railway or a waterworks, there is an easily applied check upon extravagance in construction; for it can be stipulated that the total interest on the bonds shall not exceed, say, half the normal net earnings. In the case of a non-revenue plant like a sewer or a pavement, it becomes necessary to adopt some other method of preventing excessive expenditure for construction through issuing bonds. Perhaps it will continue to be desirable to limit the bonded indebtedness to a certain percentage of the value of the taxable property, but certainly the time has come to make a thoroughgoing revision of the antique laws that are now preventing the execution of adequate programs of city improvement.

Revenue-earning plants, like waterworks, should be bondable up to an amount such that the net earnings (after deducting a liberal depreciation annuity) will cover the interest on the bonds and a sinking fund annuity.

School buildings should be bondable up to specified number of dollars per pupil; for surely no other limit should be placed upon the construction of an educational plant.

The investment in sewers bears a fairly constant ratio to the investment in the waterworks plant. If, therefore, the bonding of waterworks plants were limited by their net earnings, it would seem reasonable to limit the bonds on sewers to a specified percentage of the investment in the waterworks plants.

Street improvements, like sewers, are ordinarily paid for by direct assessments on the "property benefited"; but it is probable that the city at large will eventually pay for most of the improvement of its highways. In that event it would seem wise to limit the issue of street bonds by some specified ratio to the investment in the vehicles (other than street cars) that use the streets. This would insure against extravagant investment in city pavements for the private owners of vehicles invest in them only such sums as these means of conveyance are worth to them.

By establishing limits on bonded indebtedness along the lines just suggested, a city would escape the present throttling limitation, yet at the same time it would be prevented from making excessive investments in public works. Public works, if judiciously planned, are plants that yield a measurable profit to society. So long as the annual profit exceeds the interest on the investment, additions and improvements should be made. This economic law is completely ignored under the present system of limiting bond issues to a small percentage of the total value of taxable property.

Estimating the real profit, direct and indirect, from public works is an engineering problem. It should also devolve upon engineers to indicate how existing laws should be changed so that municipal investments in public works will bear a reasonable ratio to the estimated profit secured from them. Hitherto engineers have rarely regarded it as their function to guide the public both as to the enactment of rational economic laws and as to construction programs.

[illegible] entitled is [illegible] engineering societies [illegible] of public funds [illegible]

How Waterworks Men Can Aid the Kitchen Garden Movement

[illegible] write to the [illegible] Washington, D. C. for [illegible] War gardening and for any other literature on the raising, storing and canning of [illegible] the superin- [illegible] pamphlets he can [illegible] pamphlets can be secured free from the War Garden Commission.

[illegible] we are convinced [illegible] to stay and that it will [illegible] of revenue to city water works departments.

Judicious irrigation greatly increases vegetable crops even in the humid state of America. In 1918 the value of [illegible] back yards and vacant lots totaled more than half a billion dollars. This vast value would have been much less had it not been for irrigation [illegible] it would have been much more had more water been used.

It is the duty of every water works superintendent and engineer to encourage the use of city water for irrigation. This duty exists even in cities where there is now a scarcity of water, for the public can be persuaded, in such cases, to increase the water supply and to decrease the water [illegible]. If the [illegible] electric plant finds a way to increase the market for his electric juice, he takes steps to do so, even though his plant is already overloaded. He wisely reasons that the greater the demand for current, the sooner will he be able to persuade the directors of the company to enlarge the plant. Is there any reason why a city water superintendent should follow a different policy? None whatever. His duty to the public is to persuade the public to permit him to decrease the waste and to increase the profitable use of water. That kitchen gardening is tremendously profitable to the residents of cities is now an established fact. Study the pamphlets of the War Garden Commission and be convinced. Being convinced, act upon your conviction. Act this spring. Assist in spreading knowledge about backyard gardening

Water Consumption in Army Cantonments

[illegible] is required per capita for domestic uses, exclusive of lawn and garden irrigation? Perhaps the best answer to this query is found in the water actually used in the army cantonments. In designing the cantonment water works systems, it was estimated that 50 gal. per man and 15 gal. per mule or horse per diem would suffice. As there were three men to each animal, 55 gal. per capita per day were estimated. This was found to be more than adequate, and in 3 cantonments the average daily consumption was 30 gal. per capita per day, which corresponds very closely with the amount usually supplied in British, French and German cantonments. The 30 gal. is apparently ample for all domestic needs inclusive of sewer flushing, but exclusive of lawn sprinkling and water allowed to run to prevent pipe freezing.

There are many American cities of a residential nature where less than 50 gal. per capita per day suffices for all purposes inclusive of wastes, but in such cases all, or almost all, the consumers are metered.

Each of the 16 army cantonments was really a compact city of about 40,000 population. It is interesting to note that the cost of the water works for these temporary cities was only $11 per capita, or about one-fifth the per capita cost (at war-time prices) for a permanent city. This relatively low cost is ascribable to many factors, such as the extensive use of wood-stave pipes, the absence of pavements, the compactness of the "city," etc.

Civil Engineers Should Study the Different Forms of City Government

About 400 American cities have the commission form of government and 100 cities have the city manager (or "commission manager") form. In 1910 there were 1,245 cities of 5,000 or more population. Hence 40 per cent of the cities have abandoned the old mayor-council form of government. There are [illegible] cities of more than 30,000 population, and 44 per cent have commission government.

Within the next 5 or 6 years we may have 75 per cent of all cities over 5,000 population under commission or commission manager government. Engineering societies should assist other organizations in bringing this about. The commission manager form is preferable to the commission form of city government. Engineers should study the general features of each plan. Accordingly we print in this issue a splendid article by R. E. Bosshard, City Clerk and Assistant City Manager of Alameda, Cal., giving an outline of the respective merits of both plans.

Will Water Departments Go Into the Ice-Making Business?

Up to the present ice companies have not been classed as public utilities subject to regulation as to prices charged for their product. Yet ice has become almost as much of a necessity as water, and in many places its manufacture has become a monopoly

Many electric light companies manufacture ice, but only one city water works has gone into the ice business, namely, the Omaha, Neb., water works. George T. Prince, engineer of the Omaha Water Department, has been producing ice at a total cost of $1.50 a ton at the plant. Ice stores are located at various points in the city, and small consumers can secure ice at those stores at half the price charged by private companies. The companies deliver the ice to the customers, whereas the city merely delivers to the ice stores. This novel plan is meeting with success, and it merits the serious consideration of water works departments.

In Omaha the ice plant has a capacity of only 100 tons daily, but since the ice is stored in a 9,000-ton ice house, it is possible to provide 200 tons of ice daily during the hot months.

The power plant needed to operate an ice plant can usually be run by the same men who operate the water works pumping plant. The same superintendent and office force can be used for both the water and the ice making departments. Hence so far as wholesale production cost is concerned, it is feasible for a city water department to compete successfully with an ice company. But in the matter of delivery of ice a city probably could not ordinarily compete with a company.

A New Form Suggested for Certain State Commissions

There are many state commissions having 3 to 5 members, all of whom draw salaries for work that could be equally well performed by one salaried man. We do not refer to commissions of a judicial character, such as public service or railway commissions, but to commissions whose work is mainly executive.

There is strong agitation in California to do away with many state commissions entirely and to combine others. But it would be very expensive economy to abolish many of these commissions. A better plan is that suggested by the California State Water Commission. The commission recommends a reorganization so that there will be "one executive member" on a stated salary and two "associate members" on a per diem basis. At present each of the three members receives $5,000 a year.

Why not go a step farther and adopt the city commission-manager plan? Let the three commissioners serve either on a per diem basis or at nominal salaries, and let them select a trained executive. In this way the executive would frequently be a technical man. Thus the positions of chief engineer and executive could often be combined, not only effecting a reduction of expense but an increase of efficiency.

The Income and Expenses of Cities

About 30 per cent of our entire population live in 219 cities, that is in the cities of 30,000 and up. For the fiscal year of 1917 the total revenues of these 219 cities were $1,065,500,000, or $32 per capita. The expenses of operating these cities, including interest payments, were $24.70 per capita, and the balance of the revenue, or less than $300,000,000, was spent for improvements.

About 70 per cent of the revenue came from taxes, of which the liquor tax totaled only $37,000,000. The water supply systems yielded a gross revenue of about $84,000,000.

For 1917 the per capita outlay for permanent improvements was only $8.68, as compared with $8.91 in 1916, $10.60 in 1915, and $8.23 in 1903. This does not include the cost of permanent improvements paid for by direct assessments; and since nearly all street and sewer improvement is paid for by direct assessment, the figures just given are not very significant, except in so far as they show what a small amount the average citizen invests annually in city improvements.

The net indebtedness of the 219 cities averages only $78 per capita. This seems large until it is remembered that it amounts to only 3 per cent of the wealth of the average American citizen. Were it not for obsolete laws limiting municipal indebtedness, a very much greater per capita expenditure for public works would be made.

Construction Work Held Up by Slow Courts

Taxpayers frequently appeal to the courts when special assessments are levied for public improvements. The courts are often slow in deciding such cases, resulting in delay in beginning construction. In normal times these delays have been taken as a matter of course, but the present necessity of providing work for returning soldiers is spurring many individuals and organizations to seek relief.

In Chicago, for example, the county courts are so crowded with litigation that it has even been proposed to hire additional judges and pay them with money raised by popular subscription.

Engineering societies should interest themselves in matters of this kind, and work with other organizations to secure prompt trials of all special assessment cases.

Laws 80 Years Old Are Now Holding Back Public Works

Farmers, as a class, have long been opposed to bond issues for public works. This is partly due to the mistaken idea that a public bond is as objectionable as a private mortgage, and partly to the fear of extravagance on the part of public officials. Prof. Harold G. Moulton of the University of Chicago recently said:

"Many states have reached the limit of their bond issuing capacity and that some are not permitted to borrow at all. This is a result of the experience through which we passed in the decade of the thirties. With high hopes of great financial returns, the young middle western and southern states of those days engaged extensively in the construction of public highways, railroads, and waterways. They built beyond the needs of the time, however, and the disastrous years following the panic of 1837 carried the sparsely settled commonwealths of that day into bankruptcy. The reaction proved so strong that the amendments of the state constitutions that resulted in the forties in many cases imposed limitations upon the borrowing powers of the state so serious that now, although the conditions which existed in earlier days have passed forever, many states are still debarred from engaging in public enterprises. True, the constitutions may be amended. But the time required for such drastic procedure is so great that it could often not be accomplished until years after the transitional crisis had come upon us. There is one state, at least, where it takes six years to amend the constitution. But whether or no such states can accomplish anything in the present crisis, it is high time that steps be taken to remove the financial restrictions which now prevent constructive internal development."

In another editorial we suggest certain changes in existing laws, city charters and state constitutions relative to the limitation of bond issues.

Checks on Garbage Collection in Philadelphia

To the Editor: From your issue of Dec. 11, 1918, page 546, relative to garbage collection in this city, I quote the following:

"No check is kept on the amount of garbage collected, except that the total amount during some months is weighed and thus used as the average."

Allow me to correct this statement.

The Specifications for the Collection and Disposal of Garbage for year 1918, Paragraph 16, provides in part:

"The contractor shall facilitate the chief in securing a true and accurate count of the number and character of vehicles and weight of the garbage delivered at the plant, collection stations and other points of disposal authorized by the director for a period of six consecutive working days in each calendar month. On one day in each of these six days, all vehicles delivering garbage at any of the above mentioned places, shall be weighed both loaded and unloaded. When garbage is delivered at points of authorized disposal, not equipped with standard wagon scales, the weight of the garbage so delivered shall be approximated from the weights of similar vehicles previously determined by actual weighing at points of authorized disposal. This shall not relieve the contractor from providing standard wagon scales, so that not less than 75 per cent of the vehicles delivering garbage on the day of weighing shall be weighed."

The garbage collected under this contract is either delivered to the reduction plant or is hauled outside the corporate limits of the city to farms for hog feeding. The part delivered to the plant at 49th St. and the Schuylkill, is either hauled directly there or to the dumping wharf at 26th St. and the Schuylkill and barged from there to the plant. By far the major portion is hauled to the wharf at 26th St. and the Schuylkill, where there are facilities for weighing.

Eleven bureau inspectors are engaged in supervising garbage collections, investigating irregular collections and reporting on the same. They submit daily reports of the number of single and double wagons and trucks engaged in collecting and the total number of loads delivered by each kind of vehicle. All vehicles are numbered sequentially.

In accordance with the above quoted paragraph from the specifications, one week in each calendar month, generally the third, a garbage count is made at the plant and at the wharf. This consists in estimating to the nearest quarter each vehicle load delivered and recording the same, together with the vehicle's number. This is summarized into loads and parts of loads for single wagons, double wagons and trucks. The vehicles of each class are of standard dimensions.

In addition, on Monday of that week, each vehicle delivering at the wharf is weighed, loaded and empty; the net weights are summarized and the average weight per load for the day for each kind of vehicle is determined. These vary little from month to month. From the total number of loads delivered at the wharf during the week for each class of vehicle and the weight per full load for each class delivered on Monday, the total weight of the [illegible] is determined from the [illegible] of the plant and the [illegible] of garbage delivered [illegible] and from the daily reports of the bureau inspectors the number of loads delivered to the farms is obtained and in turn the tonnage. The [illegible] furnishes the tonnage of the [illegible]. This is apportioned over the [illegible] monthly tonnage [illegible].

Month	Tons
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	9,100
November	7,100
[illegible]	[illegible]
[illegible]	[illegible]

In addition to this tonnage there is a considerable amount collected by "private" [illegible]. This [illegible] is used for hog feeding.

ROBERT C. HICKS,
Chief, Bureau of Street Cleaning.

Philadelphia, Pa.

Definition of Engineer

To the Editor: Relative to the definition of "engineer," allow me to suggest, as I have on many other occasions, that "engineer" indicates "one engaged in engineering."

I [illegible] claim any credit for this most simple and concise definition because I copied it from the dictionary; in fact, it is given in substance if not in the identical words in at least four standard dictionaries. Every other definition of this word is open to criticism and there will never be unity of thought and purpose in the profession until it is understood to be the only correct one.

"Engineer" denoted an occupation, not a title. There is no degree of quality or ability expressed, merely the business engaged in. The words, carpenter, plumber, doctor, lawyer, etc., denoted other occupations and it is understood that there are good carpenters, doctors, etc., as well as poor ones. So it is with engineers but we have become so narrow and selfish that we do not admit it.

"Engineer" also means "one who runs an engine," because usage has established it, but it is not hard for us to distinguish between an operating and a technical engineer. It is hard for the public because no two engineers will agree on a definition so they only confuse the public the more.

Will not some of your readers admit that the dictionaries had the right "hunch" when they decided on the above definition?

ROBT. W. SHELMIRE.

Chicago, Ill.

City Water and Victory Gardens

To the Editor: We have just read in the Baltimore Sun of Sunday, Jan. 26, an article from your magazine in regard to the value of water supply in connection with Victory Gardens and we would appreciate it very much if you would send us a copy of the magazine in which it originally appeared so that we may have it for our files. The Baltimore Sun has quoted this article fully and we should like to see the original.

We are sending you some of our data under separate cover which we hope will be of interest to you and that you can have more about the importance of Victory Gardens this year. Too much cannot be said about the importance of them because of the new millions to be fed in Europe and because the markets of the world have suddenly been thrown open.

P. S. RIDSDALE.
[illegible], National War Garden Commission.

Washington, D. C.

The Waterworks and Sewerage of Buenos Aires, Argentina

By ALLAN B. LEA.

The city of Buenos Aires is built on a plain which on the western boundary of the city rises to a height of 84 ft. above ordinary low water in the River Plate, which is the city boundary on the east. On the south and part of the north side the land is lower, and in places will require to be raised to prevent flooding. The soil of the higher part is a stiff reddish clay that will stand in trenches without timbering for a long time. I may mention here a tunnel in which a cast iron pumping main was laid in this soil for a length of 2,100 ft. and at a depth of from 10 to 39 ft. The tunnel was excavated to a width of 2 ft. 7 in. and a height of 5 ft.2 in., without lining or timbering, the top being arched, and after the pipe was laid no backfilling was used. This was inspected 7 years afterwards and it was found to be in the same state as when it was first excavated; not a single lump of earth had fallen and the marks of the tools could be clearly seen. In the lower ground on the south side of the city the soil is a fine sand and requires sheet piling in the trenches.

Cofferdam in River. At Right Sewer Sections and Hopper End Section on Slipway.

The First Water Works.—Water carts formerly supplied the houses from the river, although some residents had cisterns underground to collect the rainwater from the roofs, and others had wells, but as the cesspools were dug down to the water level the water from these wells was dangerous to health.

In 1868 the first works were built to supply part of the city with water from the River Plate. The late Mr. John M. Coghlan, M. I. C. E., was the engineer for the Government of the Province of Buenos Aires, who planned this work. He proposed to supply 144,000 gal. of water per day at a cost of $236,000 for construction of works. These included an intake pipe in river, settling pools to clarify sediment from water, slow sand filters, pumping station and pumps, elevated tank to hold 72,000 gal. cast iron piping and standpipes. By the end of 1873 $590,000 had been spent on this work and some additions.

The Bateman Plans for Sewage and Water Works for Entire City.—After an epidemic of yellow fever in 1871 the Provincial Government of Buenos Aires commissioned the late Mr. John F. Latrobe Bateman, past president of the Institution of Civil Engineers, to prepare plans for sewerage and water works for the whole of the city, on the basis that in 40 years' time the population would be 400,000 on the 6,400 acres included in this scheme. By 1908, however, the population was 722,000 on this area and there were 425,000 more inhabitants spread out on 40,900 acres that were added to the city in 1887. Water was to be supplied from the River Plate at the rate of 48 gal. per day per inhabitant, of which 36 gal. were to be furnished in [illegible] hours. The works to be built immediately were estimated to cost $7,800,000 and included an inlet tower and tunnel for water supply, conduit to pumping station, pumping station and pumps, coagulation basins, filters, cast iron piping, elevated tank to hold 16,000,000 gal. (Imp.), collecting sewers, intercepting and outfall sewers, pumping station for sewage, storm water gullies and conduits. This work was started in 1873, but was stopped by a financial crisis in 1876. In 1880 the National Government took over the work from the Provincial Government and a fresh start was made in 1883. In 1888 an English company was formed to complete this work and to buy out the National Government property, but in 1891 the Government had to buy it back again.

A paper by Mr. Richard Clere Parsons, contributed in January, 1896, to the Institution of Civil Engineers, gives a fairly complete description of the work done up to that date.

From 1891 to date the Government carried on all new works under its own engineers, who are mostly Argentines.

By 1908 it was decided to prepare plans for extending the water supply and sewerage to the area outside of the districts included in Bateman's scheme, and in August of that year the plans and estimates were presented to Government. The work in the new districts was to cost $67,500,000 and $4,600,060 additional was to be spent on the old districts to bring the service up to date. It was estimated that the population of the city would reach 6,000,000 by 1952, and the water supply was taken at the rate of 79 gal. per day per inhabitant, the highest rate during the day to be 6½ gal. per hour per inhabitant. By a law passed Sept. 22, 1909, the construction of these works was sanctioned, and a start was made in 1910 and since then great progress has been made in spite of delays and financial difficulties caused by the war.

Present Water Supply and Distribution System.—The work completed during this time includes a new inlet tower in the river for the water supply, an inlet tunnel from the tower to the pump-well 4,080 ft. long, 9.85 ft. diameter, lined with cast iron segments and built with the aid of compressed air, pumping station with centrifugal pumps to raise water to coagulating basins, from which it passes to settling pools and from these to slow sand filters, divided into 21 sections, each with 24,500 sq. ft. of filtering surface, and which are grouped into seven filters, each divided into three sections. Each filter is 344 ft. by 230 ft., is 13.2 ft. deep and is to be roofed over.

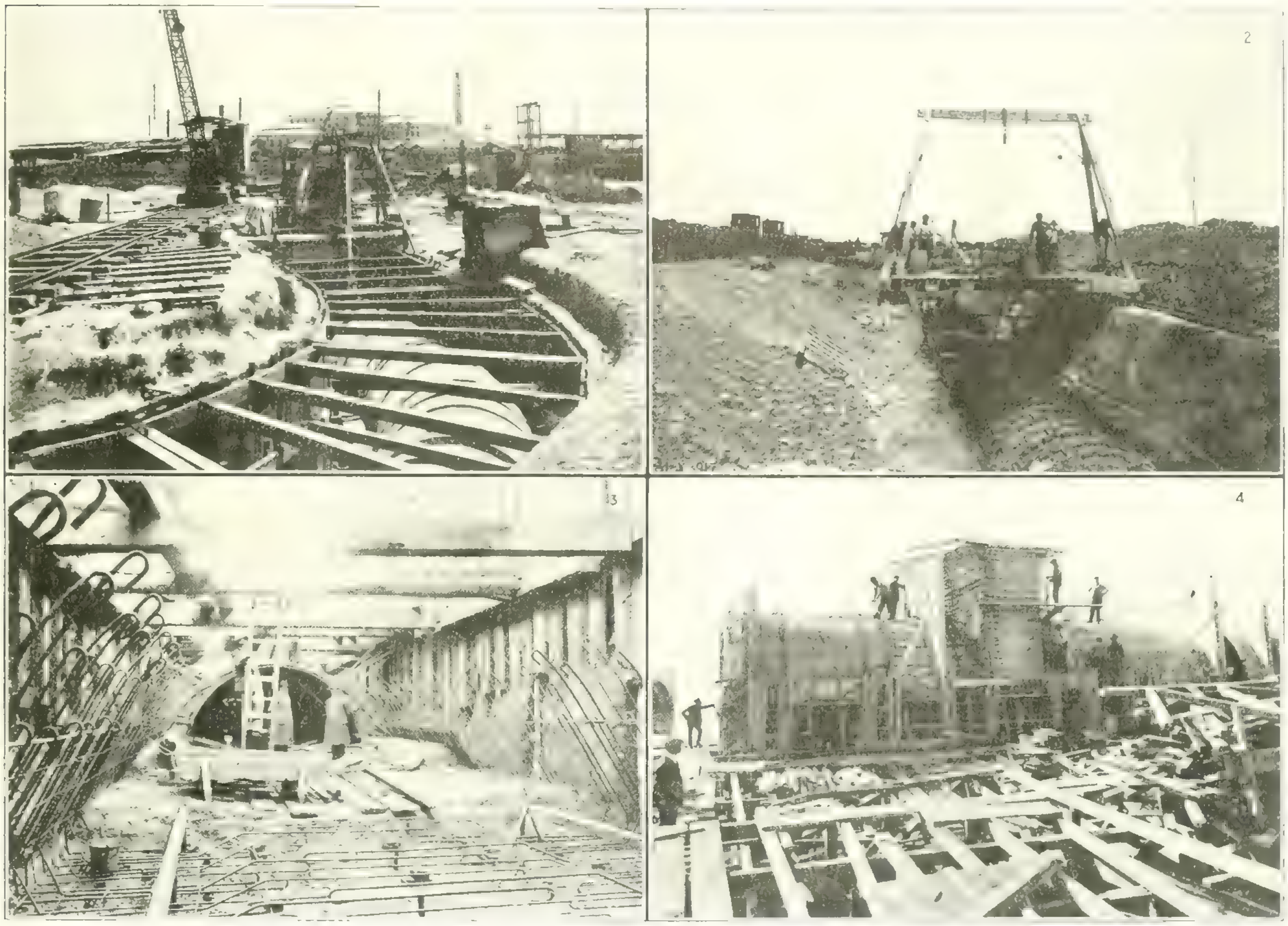

Fig. 1.—Curve on Cast Iron Section of Outfall Sewer. Fig. 2— Placing a Ring of Cast Iron Conduit. Fig. 3.—Reinforced Concrete Sewer Near River End Showing Reinforcement. Fig. 4— River End Section With Hopper.

The filtered water is pumped by triple expansion Simpson Worthington engines to two elevated reservoirs, each of which holds 19,200,000 gal. of water.

From the tanks the water is distributed all over the city by cast iron piping of which there are in the old districts 13.1 miles of pumping mains, 69 miles water mains, 563 miles distributing pipes, and in the new districts .73 miles pumping mains, 223 miles water mains, 870 miles distributing pipes and 1.65 miles hydraulic pressure pipes, or a total of 1,589.75 miles of piping, ranging in size from 3 in. to 59 in. diameter.

The Sewer System.—For the sewerage the old part of the city had been divided into 31 districts, of an average area of 240 acres each; in 24 of these districts the sewage falls by gravitation to the pumping station at Wilde, but in the other 7 it has to be raised by pumping before it is discharged into the outfall sewer. The new part of the city has been divided into 24 districts of an average area of 1,650 acres each. In 13 of these the sewage has to be raised by pumps worked by an electric motor so as to dis-

[illegible] on the other 11 higher diameter [illegible] it reaches the pump [illegible] at Wilde. In the new works the sewage is kept separate from the rainwater and the drains to carry off the rain will be built separately. The collecting sewers are of [illegible] and range in size from [illegible] in. to 36 in. diameter and are of a total length of [illegible] miles in the new part. In the old part the minimum sizing was 12 in., [illegible] and there were egg-shaped sewers of [illegible] with stoneware inverts. There were also [illegible] built in brick.

In the new part the collecting sewers discharge into the outfall sewer, which starts with a diameter of 15 in. and increases up to 9.18 ft. diameter before crossing the Riachuelo on the south boundary of the city. Up to 36-in. diameter the outfall sewer is of stoneware, and beyond that size it is built of brick in cement mortar, or of plain or reinforced concrete, varying according to the nature of the soil, and the depth at which it is built. The length of the outfall sewer with its branches is [illegible] within the city.

New Outfall Sewer Outside City.—The outfall sewer crosses the Riachuelo, a stream that is the south boundary of the city, by means of an inverted siphon, which was built in tunnel with the aid of a shield and under compressed air. Two shafts, 14.75 ft. by 14.75 ft., lined with cement concrete inside a steel caisson, were sunk each side of this stream [illegible] 141 ft. clear distance between them. The conduit was lined with cast iron segments, breaking joint longitudinally and bolted together through flanges on the outside; the internal diameter of this conduit is 9.65 ft., and it will discharge 811 cu. ft. per second. The weight of the cast iron in this conduit is 557 short tons, and the estimated cost of the whole siphon was $311,000. It was finished in August, 1917.

The banks of the Riachuelo have been raised by filling to a level of 14.75 ft. above low water. The bottom of the invert of the tunnel was fixed at 56.15 ft. below low water on the north side and 59.43 ft. on the south side. The soil was sand to 18.87 ft. below water. Below this was a bed of stiff clay 9.84 ft. thick, overlying beds of water bearing sands.

After leaving this siphon the outfall sewer was built in open cut and lined with cast iron segments forming a circle 9.65 ft. diameter till it reached the pump well at pumping station at Wilde. This section of conduit is 6.6 miles long.

After the sewage is raised by the pumps at Wilde, it is carried by six lines of cast iron piping 59-in. diameter and 2,620 ft. long to a valve chamber, from which starts a conduit 9.84 ft. diameter and 8.55 miles long lined with cast iron segments, that ends at another valve chamber 1,312 ft. distant from the shore of the River Plate at Berazategui. At this valve chamber a junction is made between the old and the new outfall sewers.

Reinforced Concrete Sewer Built on Slipway and Launched. From this valve chamber a reinforced concrete conduit was built 14.75 ft. wide and 8.1 ft. high, with a semicircular arch and was continued in the river inside a cofferdam.

Beyond this point the conduit was continued by sinking in a dredged channel reinforced concrete sections of the same dimensions internally as the work on shore. These sections were built on a slipway, weighed each 126 tons, and were 49.2 ft. long. One end of each section was shaped as a spiggot and the other as a bell, and 10 ribs were formed on the outside of each, one at each end and the other 8 in pairs, leaving about a foot space between, those at the ends leaving the same distance clear when the sections were joined together.

The slipway could hold 16 of these sections at a time. The sections were launched sideways into the river, the two ends having been closed by wood planking and a valve fixed in one end. Sixty-one of these sections were built with a total length of 3,001.2 ft. The end section in the river was provided with a hopper on top, so as to discharge the sewage into the river, and the outer end was left so that the conduit can be extended later if it is so decided.

After launching, the sections were towed out to their final position, where the bed of the river had been dredged on the line of the conduit to the proper depth. Water was admitted through the valve and the section sunk, its movements being controlled by a gantry that ran on a staging each side of the conduit under the direction of divers who saw that the sections were set to line and level and properly joined together, all these operations being checked from above water. The spaces between the double ribs were filled with concrete by means of a tremie, and under each section concrete was forced in so as to fill the dredged bed, and the whole work was covered in again to the level of the bed of the river. This was finished in July, 1918.

Cost of Catch Basin Cleaning, With Orange Peel Bucket and Truck

A special catch basin cleaning outfit, consisting of a small orange peel bucket and a 3½-ton truck, with steel body and power dump hoist, has been in service at Cambridge, Mass., for the past 6 months. The excavating and loading of the material from the basins is done with the orange peel, the bucket being opened and shut by a piston and cylinder attached to its head, which is operated by compressed air at a pressure of about 100 lb. per square inch. The outfit was described by Mr. L. M. Hastings, City Engineer of Cambridge, in our Aug. 14, 1918, issue. In the January Journal of the Boston Society of Civil Engineers, Mr. Hastings gives the following costs on catch basin cleaning in 1918 with the new outfit and with teams:

BY ORANGE PEEL AND AUTO TRUCK.

Four trips at 3 cu. yd. x 5	60 cu. yd.	
Saturday, 2 x 3 x 1	6 cu. yd.	
	66 cu. yd. weekly, or 11 cu. yd. daily average.	
Chauffeur, at $4	$ 4.00	
2 laborers, at $3.25	6.50	
Gasoline, 7 gal. at 25 ct.	1.75	
Oil	.20	
Grease	.15	
		$12.60 per day
Tires	$ 250.00	
Repairs	300.00	
Depreciation, $6,000 at 20 per cent	1,200.00	
Interest on investment, $6,000 at 4 per cent	240.00	
Yearly overhead costs	$1,990.00	

$$\frac{\text{Yearly overhead costs} \ldots\ldots \$1,990.00}{\text{Assuming 250 working days} \ldots\ldots 250} = 7.96$$

Cost per day	$20.56

20.56 ÷ 11 = $1.87 per cu. yd.

BY HORSE CARTS.

5 to 6 loads daily, average 5½ loads, 1 1/6 cu. yd. per load

1 1/6 x 5.5 loads x 5 days	32.0 cu. yd.	
1.16 x 5.5 loads x ½ day Saturday	3.2 cu. yd.	
	35.2 cu. yd. weekly, or 5.86 cu. yd. daily average.	
Labor, 4 men, at $3.25	$ 13.00	
2 horses, at $1.50	3.00	
		$16.00 per day
Interest, $575 x 2, at 4 per cent	$ 46.00	
Depreciation, $575 x 2, at 15 per cent	172.50	

$$\frac{\text{Yearly overhead} \ldots\ldots \$ 218.50}{\text{Working days} \ldots\ldots 250} = .87$$

Cost per day	$16.87

$16.87 ÷ $5.86 = $2.88 per cu. yd.

Insect Development in Swimming Pools

Swimming pool studies by the Bureau of Sanitary Engineering of the California State Bureau of Health indicate that outdoor pools are subject to algæ and insect development. The former has been recognized for a long time, but little attention seems to have been given to the importance of insect development. In one pool inspected water insects of two varieties known as "water-boatman" and "back swimmers" were found in abundance. Both varieties are small black, hard-shelled free-swimming insects. When at rest they are found on vertical walls, ropes and other surfaces under the water for a depth of 2 to 3 ft. Chemical treatment to kill the insects was tried on a laboratory scale. Chlorine gas as high as 5 p.p.m. and copper sulphate as high as 50 p.p.m. were used without success. These amounts of chemical are so high as to impair the water for bathing purposes. It is believed that the only effective method of removing the insects from the pool is by catching them with a net passed along the surfaces to which they cling. So far as known the insects are harmless but their presence does not add to the pleasure of bathing.

Financial Benefits of Metering

Interesting information on the financial benefits of metering both to the consumer and the city is given in the last annual report of Mr. Geo. H. Fenkell, general manager of the Board of Water Commissioners of Detroit, Mich. The matter following is abstracted from Mr. Fenkell's report.

The consumption in dwelling houses in Detroit, examined by selecting a number from all parts of the city at random, was as follows:

	No. of houses investigated	Size of meter, in.	Average cost per quarter	Remarks
Dwelling house....	400	⅝	$1.70	one family
Dwelling house....	89	[illegible]	2.20	one family
Dwelling house....	11	1	3.40	one family
Dwelling house....	142	⅝	2.49	two families
Dwelling house....	51	[illegible]	[illegible]	two families
Dwelling house....	4	1	5.88	two families
Dwelling house....	10	⅝	4.24	four families
Dwelling house....	72	¾	4.54	four families
Dwelling house....	18	1	5.45	four families
Dwelling house....	17	⅝	5.31	six families
Dwelling house....	11	¾	4.09	six families
Dwelling house....	63	1	6.70	six families
Dwelling house....	9	1½	7.42	six families

These figures are based on the following meter rates: First, 1,000 cu. ft. per quarter, $1 minimum charge; next, 3,000 cu. ft. per quarter, 50c per 1,000 cu. ft.; all additional 35c per 1,000 cu. ft.:

While it is not possible to determine with great accuracy what the flat rate would have been on the property listed above, a comparison of these payments with the flat rate charges for similar property will show a saving in favor of the meter charges of approximately $1 per year per family.

It is also possible to show a great saving to the city at large due to the use of meters. The following table shows the decrease in consumption with the increase in number of meters:

Year.	Average daily per capita consumption gallons	Per cent of taps metered	Per cent of water metered
1910...	[illegible]	10.1	[illegible]
1911..	[illegible]	10.3	[illegible]
1912..	[illegible]	10.7	[illegible]
1913..	175	12.1	37
1914...	171	14.4	[illegible]
1915..	162	13.3	41
1916..	[illegible]	[illegible]	[illegible]
1917..	[illegible]	44.9	59
1918..	152	62.5	[illegible]

From 1896 to 1912 the taps metered remained nearly constant at 10 per cent; that is, during this period of 16 years only enough meters were set to cover one-tenth of the taps inserted. During this time the pumpage increased at such a rate that if allowed to continue it would have reached in 1918, 195 gal. per capita per day. By increasing the number of taps metered to 59 per cent. the consumption has been reduced to 152 gal.

The expense of setting meters and the saving effected by their use can be arrived at reasonably close, although the 65,542 in use at the beginning of the year had been increased to 94,630 at the end of the year, June 30, 1918, and part of these new accounts were turned over from the flat rate ledgers during each quarter of the year.

The size of pipes 12 in. and smaller in diameter is determined by the needs of the neighborhood for fire protection, and the cost of that portion of the distribution system would not usually be affected by the use of meters.

The average daily consumption during the year ending June 30 last has been 144,704,009 gal., or say 145 million gal., of which in even figures, 39 million gallons were used in the high service and 106 million gallons in the low service. Had there been no increase in the percentage of meters in use since 1912 the pumpage would now be at the rate of 195 gal. per capita instead of 152, and the average pumpage per day would now be 186 million gallons, of which 50 million gallons would be for the high service and 136 million gallons for the low.

At the beginning of the year there were 65,542 meters in service, and 94,630 at the end of the year. As a meter set late in the year had less effect on consumption than one set earlier, it is assumed that the number in service at the end of the first half of the year, about 80,000, is the average number to use in computing costs and effects.

The installation of [illegible] meters less 10 per cent of the [illegible] of 65,000 meters has reduced the pumping station pressures, 11 per cent for the high service and 4 percent for the low service. As the pumping expense has been reduced approximately in like proportion, and as the pumping station expense during the past year was $208,[illegible] there has been a credit during the year because of reduced pumpage and pressures of $69,506 determined as follows: (50x72.7 plus 136x45.7) divided by (39x65.56 plus [illegible]) [illegible] $208,[illegible] = $69,506.

The further credit due to construction work made unnecessary because of reduced consumption due to meters [illegible] will now be determined

Item.	Total cost	Cost per million gallons	
[illegible]	$204,000		$785
[illegible]	[illegible],087,116	$[illegible]	
[illegible] construction.	[illegible]	2,413	
[illegible]	53,000	[illegible]	6,798
Station, old ..	[illegible]	[illegible]	
[illegible]	647,375	2,490	
[illegible]	[illegible]	[illegible]	
Boilers, etc.	[illegible]	1,136	
[illegible]	[illegible]	[illegible]	5,920
[illegible]	[illegible]		3,309
[illegible]	375,300		1,440
Conduits	319,614		1,230
Canals, etc.			
[illegible]	[illegible]		
[illegible]	36,980		
[illegible]	13,575	52	[illegible]
[illegible]	[illegible]		[illegible]

The interest charge and depreciation charge per million gallons capacity [illegible] computed and shown in the following table:

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Interest	[illegible]	$35.33	1½	$11.78	[illegible]
Pumps, etc.	6,798	305.91	2	[illegible]	441.87
Station	[illegible]	266.40	1½	88.80	355.20
Land and improvements	[illegible]	148.91			148.91
P. S. force mains..	1,440	64.80	1½	21.60	[illegible]
Conduits	1,230	55.35	1	12.30	67.65
Canal, etc.	[illegible]	14.85	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1,378.71	[illegible]	459.57	[illegible]
		$[illegible]		$[illegible]	$[illegible]

The saving of 41 million gallons per day in pumpage during the past fiscal year because of meters set since 1912 represents a credit in interest and depreciation of 41 million gallons x $3,006.87, or $123,282. This, added to the credit in pumping station expense,, $69,506, gives the total yearly credit due to meters of $192,388.

The average cost to the Board of meters in place has been $6.78, divided as follows:

[illegible]	$[illegible]
[illegible]	[illegible]
	$6.78

Thus the installation of 65,000 meters represents an investment of $454,700, and the interest and depreciation at 7 per cent amount to $31,829.

The yearly cost per meter follows:

[illegible]	$[illegible]
[illegible]	[illegible]
Overhead	0.06[illegible]
Total	[illegible]

65,000 meters at $0.585 equals $38,025 and the total yearly expense amounts to $69,854. This expense subtracted from the credit of $192,788 shows the saving to the city during the past year due to meters set since 1912 in excess of 10 per cent of the taps in service of approximately $122,934.

In computing the saving due to meters, it should be borne in mind that no charge has been made because of cost to the consumer in preparing the plumbing for meter. While this cost is comparatively slight for new houses, it is estimated that for both old and new the average cost is $10 each, or $650,000 for 65,000 meters. Seven per cent of this amount is $45,500, so that if this is deducted from the saving due to meters previously stated, $122,934, and it is not at all certain that such a deduction should be made, there still remains a balance in favor of meters of $77,434.

A Critical Study of the Bacterial Count in Water and Sewage*

By [illegible] STEIN

[illegible]

The bacterial [illegible] generally used [illegible] supply and sew[illegible] of the bacterial count have been subjected to considerable study and the whole procedure has been standardized, wherefore it rightly enjoys a great degree of confidence. But because of this confidence its use is often extended far beyond its scope [illegible] are taken at face value by [illegible] engineers.

If we inquire into the interpretation which we ordinarily almost subconsciously place upon this test, we find this to be that it represents all the individual bacteria in a cubic centimeter of the liquor examined. The fact that this is not true, when known, is generally reconciled by the vague conception that the number indicated is directly proportional to the total number present.

The causes which operate to make the observed results differ from the true or desired results may be grouped as follows:

1. Those arising from mathematical considerations based on the laws of chance.
2. Those due to errors or imperfections in the manipulation and technique of the test.
3. Those due to clotting of bacteria, or their adhesion to or occlusion in solid particles, causing a number of bacteria to produce but one colony.
4. Those due to failure of bacteria to grow because of unsuitable conditions.
5. Those due to accidents, such as death of bacteria, juxtaposition causing several to appear as one colony, etc.

It will be noted that causes 3, 4 and 5 all tend to reduce the bacterial count. Cause 2, while present with the best technique, may assume very large proportions in incompetent hands, and unfortunately it is usually impossible to verify the details of testing a posteriori so that results must be taken at their face value.

Mathematics of the Bacterial Count.—In considering the mathematical aspects of the bacterial count, it is well to impose certain restricting conditions:

1. It will be assumed that we are dealing with a single fair sample, eliminating all considerations of periodical and secular variations.
2. It will be assumed that the sample is well mixed and that all bacteria are free to move about so that a reasonably uniform distribution of the bacteria throughout the sample is obtained.
3. That the plate count shows all the bacteria plated and intermediate errors are eliminated.

We may consider the sample to be composed of a large number of minute droplets, each the size of a bacterium, and interspersed with these the bacteria themselves.

If we consider that a one cubic centimeter sample pipetted off for plating contains s such particles, of which α are bacteria and β are droplets of water, then:

The probability that any such particle is a bacterium

$$\therefore p = \frac{\alpha}{s} \qquad \text{I}$$

the probability that any such particle is a water droplet

$$\therefore q = \frac{\beta}{s} = 1 - p \qquad \text{II}$$

Now, it can be shown that the most probable or expected number of bacteria in a sample of n cc.'s or ns particles is:

$$\epsilon(n\alpha) = nsp, \text{ or } \epsilon(\alpha) = sp \qquad \text{III}$$

and further, that the mean error of this expected value

$$\epsilon(n\alpha) = \sqrt{nspq} \text{ or } \epsilon(\alpha) = \sqrt{\frac{spq}{n}} \qquad \text{IV}$$

The proof for these formulae can be found in the more recent text books on probabilities.

So far we have been theoretically correct in that we divided our sample into particles of the same size as bacteria. We might have used much larger droplets, distinguishing between those containing a bacterium and those not containing one. For the expression $\epsilon(\alpha)$ may be written

$$\epsilon(\alpha) = \sqrt{\frac{s\,\frac{\alpha}{s}\,q}{ns}}$$

wherein the s's cancel and q approaches unity as the size of particles decreases, for all reasonable number of bacteria (up to many million per cubic centimeter). So we may say, without appreciable error, that

$$\epsilon(\alpha) = \sqrt{\frac{\alpha}{n}} \qquad \text{V}$$

This holds practically even when several dilutions are made. For supposing a plating after double dilution to .0001 yields 100 colonies. This means an error of

$\sqrt{100}$ or 10 per cent.

The error of sampling the first dilution would be

$\sqrt{100 \times 100}$ or 100,

equivalent to 1 per cent and of sampling the original,

$\sqrt{100 \times 100 \times 100} = 1{,}000$

or 0.1 per cent. This would give a total mean error of sampling, including that due to dilutions of

$\pm\sqrt{101} = \pm 10.05$ or $\pm\sqrt{99} = \pm 9.95$.

In considering a series of determinations, the same reasoning applies. If N samples of n cubic centimeters each are taken, the most probable or expected number of bacteria per cubic centimeter is

$\epsilon(Nn\alpha) = Nnsp$, or $\epsilon(\alpha) = sp$ as before.

Similarly the expected error in the average of N determinations is

$$\epsilon(\alpha_N) = \sqrt{\frac{\alpha}{Nn}} \qquad \text{VI}$$

From these formulae the following rules may be formulated:

The expected error in bacteria per cubic centimeter based on a single sample is equal to the square root of the quotient obtained in dividing the number of bacteria per cubic centimeter by the size of the sample taken in cubic centimeters.

The expected error of the mean of N samples is obtained by dividing the expected error for a single sample by the square root of N.

The mean value of N determinations is equal to the expected value for a single sample.

We are interested in knowing the probability that the bacterial count on any plate will not deviate from the true value by more than a certain number of times the mean error. The criterion of Tchebycheff tells us that the probability P_t of a deviation of a variable from its expected value, not larger than λ times its mean error, is greater than $\left(1 - \frac{1}{\lambda^2}\right)$.

$\lambda = 3$, $P_t > 1 - 1/9 = 0.888$.
$\lambda = 4$, $P_t > 1 - 1/16 = 0.937$.
$\lambda = 5$, $P_t > 1 - 1/25 = 0.960$.

We are now in a position to plot the mathematical error of plating a sample of water or sewage, as well as the errors which may be expected once in five, ten times, etc. This has been done in Fig. 1. These values are subject to the restrictions enumerated at the beginning of this section.

Two conclusions can be drawn from this mathematical study and by inspection of Fig. 1:

1. The size of sample or the dilution should be such as to give from 200 to 400 colonies on the plate. With larger numbers the error decreases but slowly (and the greater accuracy is more than offset by interferences, etc.); while with smaller numbers the error increases rapidly.
2. There is considerable probability that, if only one plate is used, the count will depart largely from the true value.

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*[illegible] the Laboratory Section, American [illegible]

Hence the importance of making several plates [illegible] from the same sample, particularly in the case of [illegible]tection and similar studies.

Mathematical Interpretation of Results. In actual work we do not know a priori the number of bacteria in the liquor under investigation but attempt to deduce this from the tests. The vagaries of a single test have been shown in the preceding section. In laboratory tests, where we are following the same sample of sewage through various processes, a series of platings should be made at each desired step in the process. In plant control or large scale studies, it is obvious that the average of say thirty daily tests would depart much more from the true mean that would the average of thirty tests on the same sample. Let us restrict ourselves for the present to the laboratory condition.

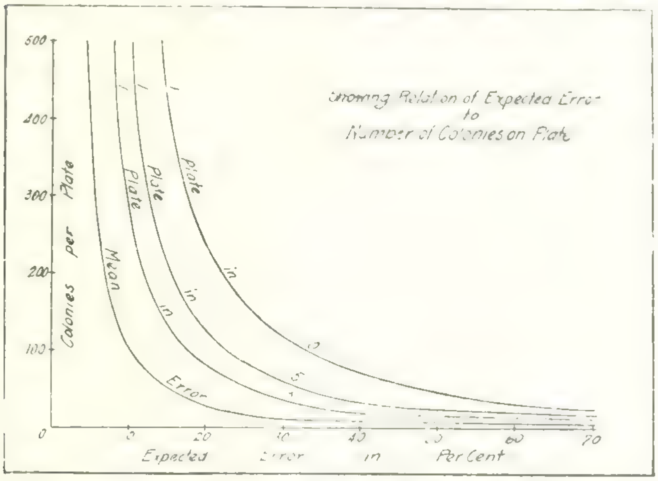

Fig. 1—Relation of Expected Error to Number of Colonies on Plate.

Suppose we have made N platings of a sample. It can be proven that the arithmetic mean is equal (theoretically) to the expected number of bacteria, $\epsilon(\alpha) = sp$ (Equation III).

Another important function is the dispersion. This may be indicated by δ and defined by the equation

$$\delta = \frac{(\alpha_1 - M) + (\alpha_2 - M) + \cdots + (\alpha_n - M)}{N} \qquad \text{VII}$$

where $\alpha_1, \alpha_2, \alpha_3 \ldots \alpha_n$ are the number of bacteria obtained on the various plates, and M is the mean value. Now, it can be shown that δ is equal to ϵ or the mean error in a single trial. Thus we are able to approximate the number of bacteria in a sample from the average of a number of platings and the deviation of same.

From a considerable number of such series of tests we may roughly formulate the following as the variations to be expected, not regarding occasional "flukes."

1. For careful and accurate work (200 colonies per plate):

a. Standard Deviation [illegible]
b. Deviation (1 in 10 times) [illegible]

2. For ordinary routine work (200 colonies per plate):

a. Standard Deviation [illegible]
b. Deviation (1 in 10 times) [illegible]

Tests Made in the Routine of Plant Operation and Control.—Obviously, in addition to the errors due to sampling and plating, as in a single sample, we here have variations in the samples themselves, which make it much more difficult to interpret results rationally.

In water supplies the variation may be periodic from season to season, as in lakes and large reservoirs, or this periodic fluctuation may have superimposed upon it very erratic changes, as those due to floods, etc., in river supplies.

In the case of sewage there are several superimposed periodic variations: a daily, a weekly and a seasonal period, and in addition a secular fluctuation due to gradually changing conditions.

The condition in which the proportion of positive to total results (that is, the probability) varies from test to test has been studied mathematically, and the series of errors thus derived is known as the Lexian or hypernormal series. It can be shown that the mean in such a series is the same, as in the usual (Bernoullian) series already discussed, but the dispersion is greater. There can be many such series, depending upon how the probability varies from test to test. An extreme and very interesting case is that in which the probability varies from zero to one (i. e., certainty) during the series of tests. Such a series can be readily studied both mathematically and experimentally by the black and white ball scheme, and may be regarded as a sort of standard for inconsistent results. (See No. 15, Hypernormal Mathematical Series (Lexis) in Table VI.)

Most statistical series are in the Lexian group so that the dispersion obtained is that of a Lexian series rather than of a normal of Bernoullian series. We have two criteria by which to judge the departure of the series from normal conditions:

a. The Lexian Ratio: which is the ratio of the dispersion computed from the actual tests to the theoretical mean [illegible] of δ (for a series of tests)

$$L = \frac{\text{[illegible]}}{\delta} \qquad \text{VIII}$$

b. The Charlier Coefficient of Disturbancy, which has the advantage of eliminating the effect of the number and size of samples:

$$100\rho = \frac{\text{[illegible]}}{M} \qquad \text{IX}$$

In Table I the Lexian Ratio and Coefficient of Disturbancy are given for a number of statistical series and error series for bacterial tests. Values for a subnormal, normal and hypernormal mathematical series are inserted to act as guide costs. It will be noted that the monthly data, based on one test a day, group around the Hypernormal Series, which we have characterized as a standard of inconsistency.

This state of affairs imposes upon the sanitary engineer, in addition to the precautions for the single test, the necessity of studying these various fluctuations, before any reliable judgment can be passed upon the bacterial content of the water or sewage in question.

In addition, it must be remembered that even when the sampling schedule covers the full scope of these variations, the deviations will be many times greater than in the same number of tests made on the liquor of constant composition.

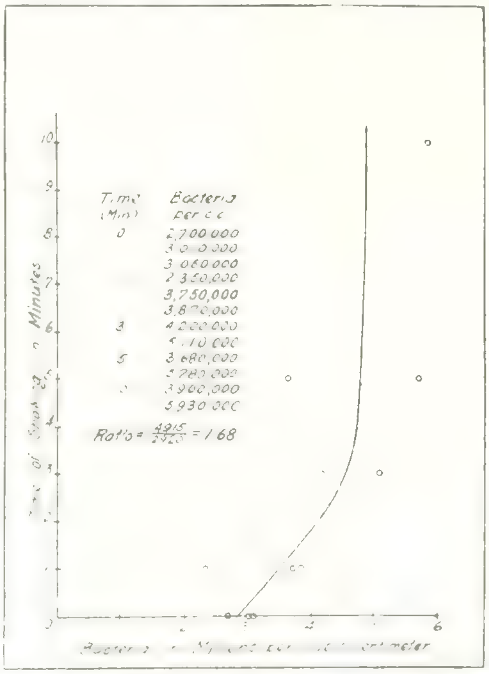

Fig. 2—Increase in Bacterial Count Due to Shaking Sewage

It is not intended to create the impression that an extremely elaborate series of tests should usually be made, but rather that the usual tests should be supplemented sufficiently by careful study of conditions to enable a fair judgment of their true significance to be rendered, and it should be realized that [illegible] usually made [illegible] very far from [illegible].

Relation of Usual Count to Total Bacteria.—The bacteria count [illegible] the number of bacteria present, [illegible] and manipulation are [illegible].

[illegible] under the high power [illegible] particles to which numerous [illegible] that many [illegible]. The writer has [illegible] such bacteria previous to [illegible] shaking the sample for ten minutes [illegible] sand. A [illegible] increase of 61 per cent over the usual method. In Fig. 2 are given the [illegible] of various periods of shaking.

[illegible] of the types which do not find the media and conditions favorable to develop[illegible]. In investigating this question the writer made use of a method, the application of which to sewage work he believes to be novel, i. e., the direct count. The sample, after vigorous shaking with sand as above outlined, is stained with methylene blue. A drop is then placed on a blood-counting cell and counted under the high power microscope. (This method shows some promise as a means for rapidly determining the bacteria in sewage, aside from its usefulness in this case.) In one instance, where the average of ten tests by the usual method gave 3,950,000 per cc., the direct count gave 70,720,000 as the average of ten counts made by two observers. This latter figure included dead cells and probably some minute organic particles which might have been mistaken for bacteria, but the difference seems too great to explain away on any such grounds. Since making the above tests the writer's attention has been called to the fact that recently work along similar lines has been done on soil analysis, giving about twenty times as many bacteria by direct [illegible] the plating method.

Applying the Standard Method to Special Conditions.—In applying the standard count to unusual conditions considerable caution should be used if it is desired to avoid erroneous interpretation of results. As an example, the usual method of interpreting disinfection tests suggests itself. A raw sample and a disinfected sample are plated and incubated at 37° C. for 24 hours. The raw count is 2,000,000, the disinfected count, 20,000. The plates are returned to the incubator and counted again at the end of 48 and 72 hours. The raw will remain approximately constant, but the disinfected sample may give counts of 60,000 and 100,000 respectively. Apparently some of the bacteria were merely stunned or weakened by the disinfectant and only recovered sufficiently to develop as visible colonies one or two days later. This is quite apart from the question of "after-growths" which are due to multiplication of the bacteria, which have not been destroyed, in the water itself. Other cases where the literal use of standard methods will not yield the desired results will suggest themselves to the reader.

Conclusions.—It has been shown that for platings of a uniform sample:

a. The expected error in a series of bacterial counts is given by the formula:

$$\epsilon(a) = \sqrt{\frac{a}{Nn}}$$

b. That consistent with convenience, from 200 to 400 colonies per plate give the greatest accuracy.

c. That for ordinary work three, and for accurate work, five or ten platings should be made of each sample, a single plating being unreliable.

d. A study of Table I shows that with sufficient care the error in determining the bacteria in a single sample can be made to approach the normal error of sampling, putting such determinations in a class with other reliable statistical data.

Further study of Table I shows that the results of a series of bacterial samples taken from day to day are extremely inconsistent. The criteria show this inconsistency to be due both to errors in the single sample, which can be eliminated to a large extent, and to the fact that the samples were not properly apportioned to the variations in the water or sewage, which source of error can be reduced by study of these variations. In these days of standards for filterable water, drinking water, etc., would it not be well to inquire into the nature of the rule which we are using for our measurements, both to determine its actual length and establish its accuracy?

It has further been shown that usual methods do not give the total number of bacteria present, due to clotting and unsuitable conditions for their growth. Rather perfunctory tests indicate that the number developed by plating is not over 10 per cent of those present, but a review of governing conditions will convince that no constant proportion can exist.

It has also been shown that under unusual conditions the standard method gives distorted results, and that for special work modifications to reduce these distortions seem advisable.

TABLE I. COMPARISON OF THE CHARACTERISTICS OF ERROR SERIES IN BACTERIOLOGICAL TESTS WITH THOSE OF COMMON STATISTICS AND MATHEMATICAL SERIES.

Description	Lexian ratio	Disturbancy coefficient
1. Subnormal mathematical series (Poisson)	.98	[illegible]
2. Selected mortality series (life insurance)...	1.00	0.0
3. Normal mathematical series (Bernoulli)....	1.00	0.0
4. Birth series (a)	15.50	[illegible]
5. Birth series (b)	12.50	1.5
6. Fortunate series of ten plates on crude sewage	1.15	4.60
7. Marriage series	1.40	0
8. Careful series of fourteen plates on crude sewage	2.22	1.00
9. Ordinary series of ten plates on crude sewage	2.26	15.5
10. Ordinary series of ten plates on crude sewage .. .	3.43	25.00
11. Ordinary series of ten plates on disinfected sewage	6.15	29.00
12. Daily tests for one month on crude sewage	5.30	41.00
13. Daily tests for one month on crude sewage	8.2[illegible]	47.60
14. Daily tests for one month on crude sewage	9.00	49.00
15. Hypernormal mathematical series (Lexis)..	7.40	50.80
16. Daily tests for one month on Lake Erie water	29.00	124.00
17. Daily tests for one month on filtered water	10.85	178.00

NOMENCLATURE AND FORMULAE

a = Number of bacteria per cubic centimeter.

β = Number of arbitrarily small particles of water per cubic centimeter.

s = Total number of particles per cubic centimeter, $s = a + \beta$.

p = Probability of drawing one bacterium, $p = \frac{a}{s}$.

q = Probability of not drawing one bacterium, $q = 1 - p$.

n = Number of cubic centimeters in each sample tested.

e = Expected Value; $e(a)$ = expected value of a, etc.

ϵ = Expected Error; $\epsilon(a)$ = expected error of a, etc.

N = Number of determinations.

λ = Size of error in terms of ϵ.

M = Mean value.

a_1, a_2, a_3, etc. = Number of bacteria per cubic centimeter in the individual samples of a series.

σ = Standard deviation.

L = Lexion ratio.

ω = Charlier coefficient of disturbancy.

[illegible]

$$\epsilon(a) = \sqrt{\frac{a}{n}} \text{ for a single test}$$

$$= \sqrt{\frac{a}{Nn}} \text{ for } N \text{ tests.}$$

$$M(a) = \frac{a_1 + a_2 + \ldots a_N}{N}.$$

$$\sigma = \sqrt{\frac{(a_1-M)^2+(a_2-M)^2+ \ldots . (a_N-M)^2}{N}}.$$

$$L = [illegible]$$

$$\omega = [illegible] \sqrt{M} [illegible] 100$$

Centralized Drainage Authority for Minnesota.—Centralized authority for drainage matters in Minnesota was recommended by Governor J. A. Burnquist in a message to the State Legislature. He suggested that the present drainage commission be abolished and its power vested in a state drainage engineer, who should be authorized to expend large sums for topographical and hydrographical surveys. He also suggested that this official might be aided by an advisory board consisting of engineers familiar with drainage matters and serving without compensation.

Measuring and Recording Deliveries of Irrigation Water to Farms

In our issue of Nov. 13 we described the various methods of measuring irrigation water deliveries to farms, the matter being taken from an article by Mr. J. S. Longwell, assistant engineer, U. S. Reclamation Service, in the Reclamation Record. In the same article Mr. Longwell pointed out the importance of these measurements to the water users and to the project interests. An abstract of this portion of the article, together with a discussion by Mr. D. C. Henny, consulting engineer, U. S. Reclamation Service, follows:

Together with a well installed system of measuring devices, it is essential for good results that a good system of records be kept. To do this it is necessary that accurate gauges, reading to hundredths of feet, be installed on all measuring devices, that daily readings be taken by the ditch riders on all deliveries, and that the ditch riders' daily records be promptly worked up in the office to obtain the total water used by each man as the season progresses. These records should be up to date at all time to be available in case of inquiry. Monthly statements should be sent each water user informing him of the total water used to date and the charge for the same.

Limitations of Accuracy.—The measurement of water to the farm can not be made under ordinary conditions with a high degree of accuracy. It is impossible from an economic standpoint to install expensive recording meters and consequently it is usually found necessary to rely on a daily reading by the ditch rider on a weir, orifice, or other device.

The average project has thousands of farm deliveries to handle and it is to be expected that stilling pools will become fouled, gages will be destroyed or be moved, weirs will submerge, and numerous other troubles will develop which tend to cut down accuracy.

Discrepancies may occur due to the gates being jammed with weeds for a part of the time. The flow of water may increase or decrease between the ditch rider's daily readings and no record is had of the change.

Any of the above conditions have a tendency to reduce the accuracy of the measurement and if they were all such that the error was in the same direction in all cases, the discrepancies would be serious, but it is found that the errors tend to balance each other; that is, the errors tending to decrease the discharge are balanced by those tending to increase the discharge.

If proper care is taken in selecting types of measuring devices to be used for the farm deliveries operating under the various flow conditions and the structures are located and installed properly, there is every reason to believe that good results can be obtained. The results, of course, will not be as accurate as if they had been made under laboratory conditions but will be within the necessary limits of accuracy for irrigation work.

In distributing and measuring water, it is not so essential that highly precise results be obtained as it is that the same degree of accuracy exist for all deliveries, thus resulting in an equitable distribution. It is essential, however, that these results be within reasonable limits of accuracy in order to be of any benefit.

To obtain good results it is very essential that the measuring devices be kept in good operating condition from year to year and that the gages be kept accurately set. It is a very easy matter to allow these devices to deteriorate if they are not frequently examined and if the devices are considered necessary in the first place it is equally essential that they be kept in repair.

Importance to the Water User.—As a result of the installation of a well-designed and constructed system of measuring devices, the farmer, after a short time, is able to tell exactly how much water he is getting from day to day and to know whether or not he is getting his proper irrigating stream.

At the end of each month the farmer should get a statement of the quantity of water used during the month and his charge for water to date. These items have a tendency to encourage the farmer to a more economic use of water and to prove to him the benefits and advantages of using as large irrigating streams as his land will permit.

The man who economizes and does not waste water obtains the advantage over his neighbor who wastes water in that his water bill is much less than his neighbor's. They each pay for exactly what they receive and the man who can handle the water best gets the benefit. As a result it puts a premium on the economic use of water.

Importance to the Project Interests.—Perhaps the greatest benefit derived from measurement of water to the farmers is the assistance to the operating men in intelligent distribution of water. Under the old system of delivering water by guess there was always more or less trouble because one man thought another was getting more water than he was. Although it is not possible to eliminate this trouble altogether, the assistance of good measurements goes a long ways toward it and gives the operating man something reliable to work with and does away with the hit and miss of the former system. The operating man can find from the records exactly what water each man on the project received and when he received it. This information is invaluable in settling questions of water delivery which arise throughout the irrigation season.

By measuring all water delivered to farmers and basing the operation and maintenance charges on one quantity of water used, the entire project is placed on a business basis, each farmer paying for exactly what he gets in the same manner as he buys any commodity from any business house. From the quantity of water sold to each farmer, the men who handle the water economically are known and those who waste water are also located, and a material increase in the duty of water will result.

From the records of the amount of water delivered to the farms together with other hydrometric data, the losses in various parts of the system are known. This information frequently proves valuable in eliminating seepage losses. This information is also valuable in distributing the water through the various canals and laterals as losses must always be considered in proper handling of the water.

It frequently happens that enlargements or extensions of present projects are proposed. The first question that arises is the water supply. On most projects there is a considerable portion of the project not yet under cultivation and the first question to be decided is the ultimate project requirements in the light of the requirements of the land now under cultivation.

If a thorough system of measurements to the farms has been established on the project and records are available for the past few years, it is a simple matter to consider any proposed extension or enlargement. The canal losses are known and the duty of water for various types of soils. This information may be applied together with hydrometric data on canal capacities and a complete solution made with little trouble.

In case no such data are available, it is then necessary usually to make special investigations, install a system of measuring devices, and it is usually necessary to base the question of an enlargement or extension on one season's results. It is always difficult to install such a system and to get the very best results in one season and there is no question but that the best interests of the project in every way could have been served by having had in operation a system of measurement to the farms together with a general hydrometric plan.

In connection with drainage problems which are constantly coming up on the various irrigation projects, it is essential for a thorough study of ground-water conditions to know the amounts of water used in various localities. Where such data are available a large amount of guesswork as to the amount of water to be handled is avoided and a much more rational solution of the drainage problems will result.

In the operation of a project numerous instances occur [illegible] good system of [illegible] land is put under [illegible] to obtain a greater [illegible] available these points [illegible] forcibly than [illegible]

Discussion by D. C. Henny, Consulting Engineer, U. S. R. S.

The paper of Mr. [illegible] is especially valuable because of the [illegible] to obtaining a fair [illegible] of farm deliveries.

The primary [illegible] of such measurement is to determine the [illegible] to be made to each farmer for operation and maintenance, as required by law.

Although this primary purpose renders accurate measurement important, attention is called to other and equally [illegible] uses which can be made of the results, provided errors can be kept within a narrow range.

The method of charging for operation and maintenance [illegible] a minimum amount required under skillful irrigation. It is becoming customary to ascertain this amount for various classes of soil, and to require payment for such amount on a flat basis and payment for excess on an acre-foot basis. The best basis for ascertaining this minimum for various classes of soil is the record of farm deliveries, provided they have been accurately ascertained.

Such measurements also form the basis for designing the required capacity of laterals and canals in connection with further project development.

In the somewhat common case of insufficiency of canal capacities, and in considering means of improvement, it becomes necessary to study seepage losses. Such losses in the main canals may be determined by direct canal-water measurement, but the losses in the lateral system must be obtained by deducting from the water turned in at the head the amount delivered to the farms.

The annual operation and maintenance reports state both farm deliveries and seepage losses, but the lack of accuracy of the reports is in many cases admitted, owing to unfavorable conditions such as silt in water and lack of available fall under which present devices operate.

So far as charging the farmer for water delivered to him is concerned, it is but natural that under such conditions the farmer be given the benefit of the doubt, in other words, that he be charged with less water than he probably received. Thus the aggregate of all farm deliveries as reported is likely to be too low and the estimate of seepage losses is consequently apt to be too high, which may lead to entirely erroneous conclusions.

Drainage is becoming an important and expensive requirement on most irrigation projects. The study of drainage requirements is very complex. The important element underlying it is the water lost by seepage. This must be approximated partly from the record of canal losses, the determination of which largely depends upon the accurate measurement of farm deliveries as stated above. It is in addition dependent upon the amount of losses directly due to irrigation.

Irrigation losses can, with our present state of knowledge, be but imperfectly known. Some losses occur even where irrigation is most efficient. The bulk of the losses results from inefficient irrigation and the writer knows of no better way to study irrigation losses than by a comparison of amounts used on the farms. Excesses over a minimum, such as efficient irrigators deem sufficient, may generally be regarded as entering the subsoil and joining the water plane and for their proper estimate accuracy of farm delivery measurement is essential.

There is yet one more important use to which such measurements may be put. Information as to net duty accumulated on various projects constitutes the most valuable knowledge now available to the engineer for estimating the requirements of future projects. Although this may not be of direct benefit to projects already completed, it is of importance to the Reclamation Service as a whole and to irrigation engineers generally, who begin more and more to look for necessary information to the records prepared by the Service.

Electrically Driven Pumps in Small Waterworks*

By D. D. EWING,

Professor of Electrical Railway Engineering, Purdue University

Advantages of Electric Motive Power for Driving Pumps.—As practically all forms of so-called "power" pumps—centrifugal, rotary and displacement—can be adapted to electric drive, the questions arising relative to the application of electric motors to municipal pumping are those pertaining to first cost and operation rather than mechanical design. In brief, the advantages commonly claimed for electrically driven pumps are: Lower first cost, lower operating expense, greater compactness and simplicity, require less attendance and are more convenient than other forms of drive.

Where water is pumped from widely separated wells electric drive is particularly advantageous. Pumps so driven may readily be arranged for automatic operation, starting and stopping automatically at pre-determined pressures on the discharge mains.

Energy Required by Electrically Driven Pumps.—This is usually expressed in kilowatt-hours per 1,000 gal. of water pumped. This is not a very satisfactory duty unit as pumps work between wide ranges of suction lift and discharge head and their energy requirements, therefore, differ greatly. For large low head pumps the energy requirement may be as low as 0.4 kilowatt-hour per 1,000 gal. and for small high head pumps as high as 10 kilowatt-hour. For average conditions 1.25 kilowatt-hours per 1,000 gal. seems a fair figure. The energy cost, of course, depends on the electric rates and they, too, vary through a wide range, being dependent on size, kind and location of the control power station. These rates usually contain a demand charge and an energy charge both graded as to magnitude of the customer's requirements. A rough average flat figure for small stations is 5 ct. per kilowatt-hour. For larger stations 2 ct. per kilowatt-hour is probably nearer the correct average.

Power Requirements.—The engineer who applies an electric motor to a given drive must have a very accurate knowledge both of the characteristics of the motor and pumps and the requirements of the drive if the installation is to be successful.

Several types of pumps are available and in general pumping can be classified into deep well and surface pumping. The latter class includes all of the suction lifts low enough to permit the pump being placed at the ground surface.

For deep well pumping, displacement, centrifugal, propeller and air-lift pumps are in common use. For the displacement pumps; that is, those using a plunger or a piston, a pumping head to change the rotary motion of the motor to the reciprocating motion of the pump is necessary. This head must be geared to the motor because the lowest economical motor speed would still be far too high for the pump. Centrifugal and propeller pumps for deep well pumping are driven by direct-connected vertical shaft motors. Obviously the motor and pump speeds must be mutually adapted and this requires care on the part of the pump manufacturers. Alternating current motors are most commonly used in small municipal plants and their speeds are fixed depending on the number of poles of the motor and the frequency of the alternating current. For the common frequency of 60 cycles the standard small motor speeds are 1,800, 1,200, 900, 600 and 450 revolutions per minute. In connection with air-lift pumps motors may be used to operate the air compressors.

For surface pumping, displacement, centrifugal and rotary pumps are used.

The output rating of an electric motor is limited by the heating of the motor windings. The rating assigned by the manufacturer is that output which the motor can carry continuously without overheating the windings. Because of this heating limitation, some care must be taken in selecting a centrifugal pump which is to be mated to a motor.

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*From a paper presented Jan. 21 at the annual convention of the Indiana Engineering Society.

For a pump of suitable design for operation with an electric motor the curve showing the relation between head and rate of discharge should be comparatively flat until rated discharge is reached. Thereafter the head should decrease rapidly. Such a pump is said to have a drooping characteristic. As the power required to operate the pump decreases as the head decreases the possibility of seriously overloading the motor, in case of a break in the watermain, is avoided.

As protection to the motor where displacement pumps are used, suitable safety valves must be provided in the discharge line to prevent the pressure from being built up to a dangerous value when the demand in the pump is low. The motors best suited for pumping service are the three-phase, squirrel cage induction motors for alternating current and the shunt motor for direct current. The alternating current motor is extremely rugged, simple and reliable, has no moving electrical contacts and may be secured with moisture-proof windings. Both types of motors and all well designed high speed centrifugal pumps are equipped with ring oilers and will run continuously for long periods with only occasional inspections.

In addition to type of pump the application engineer must know the required discharge, the total pumping head, the kind of electrical energy available, whether direct or alternating, and if the latter, the frequency. The total head is fixed by the suction lift, the pipe friction, and the discharge head. Working pressures vary widely in different towns. For ordinary service the common range is from 30 to 50 lb. per square inch, while for fire service, pressures ranging from 50 to 100 lb. per square inch, are in common use.

The following actual examples illustrate in a general way the motor application problem. The figures are of the pre-war period, the example chosen being considered rather more typical than one in which the present fluent cost and labor conditions would be involved

Concrete Illustration of Motor Application Principle.—A town of 2,500 population has a steam pumping plant which has been in service for 20 years and is now about ready for the scrap pile. The direct pumping system is employed and funds are not available for the erection of a standpipe or tank. Three-phase 220-volt 60-cycle power of high reliability is available. The ordinary working pressure is 40 lb. per square inch, but for fire protection purposes 65 lb. per square inch, with enough capacity behind it to supply two 1⅛-in. nozzles is desired. At this pressure two such nozzles will discharge about 400 gal. per minute.

Meter readings of the domestic requirements were taken during two summer periods, one of 6 days in August, the other of 15 days in September. For the first period the average discharge was 170 gal. per minute. The average number of gallons per minute for day service (6 a. m. to 7 p. m.) was 190; for night the average was 144 gal. The average for the second period was 168 gal. per minute. The maximum discharge noted was 240 gal. per minute. It was only of short duration. The suction lift and pipe friction were such that for ordinary pressure the total head was approximately 110 ft., and for the fire pressure 165 ft.

For ordinary service the data indicate that a 200-gal. per minute pump is large enough and for fire service a 500-gal. per minute pump. In case of fire the larger pump would be started and the smaller one shut down. Had it been a standpipe installation, a larger low head pump would have been advisable as it would have to run fewer hours per day to maintain the water level. Also, automatic starting and stopping would have been desirable. For the conditions in hand centrifugal pumps best fit the requirements and they were selected.

The sizes of motors necessary to drive these pumps may be calculated

$$\text{HP.} = \frac{\text{Gallons per minute} \times \text{total head}}{4{,}000 \times \text{pump efficiency.}}$$

For the case in hand the figures are 9¼ and 31 HP., respectively. The nearest commercial motor sizes are 10 and 35 HP. and these were selected.

Cost of Changing to Electrically Driven Pumps.—The estimated cost of changing to electrically driven pumps, including changes to the pumphouse and some suction line alterations was $3,000, the pumping units themselves costing $475 and $850, respectively. The cost of similar units today would be about twice that, the costs of a line of well designed modern centrifugal pumping units, capacities up to 2,000 gal. per minute, for 100-ft. head, being given by—

Cost = $850 + $34 n where n = number of hundreds of gallons per minute rating.

For 200-ft. heads the

Cost = $1,600 + $107 n.

The pump costs alone can be figured from

Cost = $540 + $7 n on 100-ft. heads and

Cost = $1,200 + $53 n for 200-ft. heads.

The fixed charges on the new installation at 15 per cent a year amount to $450 per annum. The salvage of the old steam plant actually decreased the investment a small amount, but this was not considered in the above estimate.

The estimated operating expenses of the new plant were $1,500 per year. This included one-sixth of the time of a water works employe who spent the rest of his time on other work. Energy for the operation of the pumps was obtained at an average figure of 1.85 ct. per kilowatt-hour, the actual rate being of the familiar sliding scale type. The estimated energy consumption per 1,000 gal. was 0.8 Kw. hours, and the energy cost 1.48 ct.

The average operating cost of the old steam plant for 3 years preceding the time in question was in round figures $2,900 per year. Of this amount nearly 50 per cent was fuel cost. The entire time of two men was necessary for the operation of the plant.

For the last year of steam operation the average fuel consumption was 14.7 lb. of coal per 1,000 gal. The average fuel cost was 1.8 ct. and the average cost of attendance 1.27 ct. per 1,000 gal. With the present prices of fuel and labor the saving in operating expenses would be nearly double the $1,400 per year indicated by the above figures.

American Society of Civil Engineers Adopts Resolutions for Vigorous Prosecution of Public Works Construction

The following resolutons were adopted unanimously at the annual meeting of the American Society of Civil Engineers, New York City, Jan. 15, 1919, at which 650 members were present:

"Whereas, It is vital to the peace and welfare of our country that, during the necessary reconstruction period following the war, the number of unemployed be reduced as much as possible; and

"Whereas, The development of transportation, sanitation, power, and public utilities generally is necessary to the development and prosperity of the country; and

"Whereas, The curtailment of needed public works during the period of the war has retarded the development of the country; and

"Whereas, The speediest and most effective means to prevent the suffering, distress, and demoralization resulting from unemployment is afforded by public works; and

"Whereas, The public welfare and confidence, upon which industry generally depends, require that the construction of public works be vigorously prosecuted; therefore, be it

"Resolved, That the American Society of Civil Engineers, assembled in their sixty-sixth annual meeting, this 15th day of January, 1919, desires to record its profound conviction that public works should be carried forward to the fullest extent consistent with sound judgment, not only for fundamental economic reasons, but for humanitarian reasons, to furnish employment for all who can properly claim employment, especially returning soldiers; and be it further

"Resolved, That copies of this resolution be forwarded to such Federal, state and municipal authorities as may be able, in the opinion of the Executive Committee of the Board of Direction of the Society to promote the purposes of these resolutions."

Shooting Water Wells with Nitro-Glycerin

[illegible]

[illegible] practical use on the [illegible] at Twin Bridges, Del., on [illegible] a drilled water well. [illegible] with nitro-glycerin to en[illegible] common practice [illegible] of the ordinary

The country in this section of Delaware is rolling and [illegible] a rather deep valley [illegible] which were to be sup[illegible]

The drilling was done with a regulation well drilling [illegible] formation for the first [illegible] an 8-in. iron pipe was driven in for this distance. After that rock was struck, and no piping was necessary.

Shells of Nitro-Glycerine Ready for Lowering. The Man in the Center Is [illegible] Hook Used for Lowering the Tubes.

Water was encountered at a depth of 270 ft. Drilling [illegible] to a depth of [illegible] ft., but as no more water was found work was stopped and it was decided to finish the operation with nitro-glycerin.

The nitro-glycerin used was in the solidified form as it is more convenient to handle this way than in the liquid state. As the handling and firing of nitro-glycerin requires expert knowledge and a great amount of skill the American Glycerin Co. was called in to perform this end of the work.

The nitro-glycerin was loaded into six shells, each shell containing 25 qt. These shells were 5 ft. long and 6 in. in diameter. The closed end of each shell was pointed, thus allowing it to fit tightly into the top of the next shell below.

It will be remembered that water was struck 80 ft. from the bottom of the hole. To secure the desired results from the shot it was necessary to place the nitro-glycerin opposite the water-bearing stratum. To accomplish this an anchor made in sections totaling 65 ft. out of 1½ in. galvanized iron pipe was attached to the bottom of the first shell that was lowered into the well. The other shells in turn were then lowered into position. By this arrangment, it will be seen that a cartridge or shell of nitro-glycerin, 30 ft. long, the center of which was 80 ft. from the bottom of the hole—where water was first struck—was in position to fire.

To detonate this nitro-glycerin a "Jack Squib" was used. This squib was made from galvanized iron and was 36 in. long and 2 in. in diameter. The pointed end was closed and in this a few inches of sand were poured. On top of this sand 1 pt. of nitro-glycerin was placed and in the nitro-glycerin was inserted two No. 8 blasting caps to which had been previously attached about 36 in. of a slow-burning waterproof fuse. The remaining space in the Jack Squib was filled with a waterproofing substance. The two pieces of fuse protruded a few inches above the top of the jack [illegible] so in the event of one fuse misfiring the other would fire the cap and detonate the charge. The end of the fuses were split, then lighted. The jack squib was then dropped into the hole.

The squib weighed 7 lb., so it sank to position, easily overcoming any water resistance.

At the beginning of the operation the water in the pipe was about flush with the top of the ground. The force of the explosion threw this column of water into the air several hundred feet.

Cost of Tile and Concrete Sections of Rideau River Intercepting Sewer, Ottawa, Ont.

Work was started in December, 1916, on the construction of the Rideau River interceptor, a 17,900-ft. sewer that will drain a portion of south and east Ottawa. The first section was constructed of segment tile, 60 in. in diameter; the next section is of 54-in. pipe, part segment and part concrete. A third section was built of 48-in. concrete pipe. The following cost data on the work are abstracted from an article by L. McLaren Hunter, City Engineer's Department, Ottawa, in The Canadian Engineer.

The larger equipment used during construction included one 45-HP. boiler, one 40-HP. boiler, one derrick and traveler, three syphons, one 4-in. submerged pump (electric) and one 4-in. suction pump (electric).

The costs of various materials used were as follows:

1917—54-in. concrete pipe, per ft.	$4.31
48-in. concrete pipe, per ft.	3.44
1918—48-in. concrete pipe, per ft.	4.30
30-in. concrete pipe, per ft.	2.35
1917—60-in. Natco tile, per ft.	5.65
1916—Cement, per bag	.43
1917—Cement, per bag	.52
1918—Cement, per bag	[illegible]

On the 60-in. Natco tile section, in 18 ft. of excavation, the costs were as follows:

	Per lin. ft.
Excavation and backfilling	$8.240
Pipe laying	.375
Natco tile, including underdrain	7.426
Pumping	.766
Shoring	.652
Grading, plant, sundries	1.744
Total cost per lin. ft.	$19.203
Tunnel section (excavation), per ft.	19.35
Manholes (concrete), each	61.46

The cost of 48-in. concrete pipe section, in 4 ft. 6 in. of excavation, in 1918 was as follows:

	Per lin. ft.
Labor:	
Excavation	$1.37
Shoring	.68
Pumping	.20
Backfill	.60
Culvert drains	.16
Rolling pipe	.29
Running hoist	[illegible]
Derrick and track	.44
Grouting	.12
Pipe laying	.34
Sundries (including Saturday afternoon holidays)	.58
Total	$5.11
Material:	
Pipe (including hauling)	$3.60
Coal	.24
Cement	.11
Sundries	.11
Total	$4.06

The above costs on the 48-in. section were taken on 400 lin. ft. of work which was done in August, 1918. Laborers were paid 35 ct. per hour. On the Natco tile section, laborers were paid 27½ ct. per hour. The work was done by day labor.

Metering Reduces Per Capita Water Consumption from 140 Gal. to 52 Gal.—In a discussion at the November meeting of the New England Water Works Association, Mr. Lewis R. Dunn stated that when he took charge of the water works at Winthrop, Mass., the population was 8,000 or 9,000 and the water consumption about 140 gal. per capita. The present population is between 15,000 and 16,000 and the per capita consumption in October was 52 gal. This reduction, Mr. Dunn, stated was brought about by the installation of meters. He added that for 3 years running the town had been able to account for all but 3 per cent of its water.

Why the Commission-Manager Form Is Preferable to the Commission Form of Government*

By R. E. BOSSHARD.

City Clerk and Assistant City Manager, Alameda, Cal.

"With one hundred years of experimentation in charter making one marvels that somewhere in the cities of the United States there has not been produced a charter which adequately provides for the government of a city. The quest for a model charter has been persistent, indefatigable, but as yet it appears to have been unrewarded. Since the time that city government began to develop into the proportions of a problem, reformers have divided their efforts between attempts to drive rascals out and attempts to frame a charter that would bring about good government. By nothing more than their charters do American cities reveal the unscientific manner of their government, and this is true of the new plan as of the old."

Thus wrote Henry Bruere, former Chamberlain of the City of New York, in one of the closing chapters of his book, "The New City Government," published in 1912, after having discussed in thorough detail the workings of ten cities under the commission form of government.

In a word, the commission form of municipal government has by no means solved the perplexing problem of city government. Its advent in the United States was some twelve years prior to the date above mentioned and was hailed as the final word in charter making. That it showed improvement over the older form—that of the Mayor-Council plan, also known as the federal plan, since it was modeled after our federal government—experience has demonstrated.

Under the commission plan each commissioner was clothed with responsibility of the charge of a department. Since he was elected at large, the welfare of the entire community came within his official sphere. No single section was favored to the detriment of the others and the public felt that a greater measure of responsibility to it had come to pass.

As the commissioners are well paid for their services, they give more attention to their duties. What was once everybody's business has at least become somebody's business and closer attention to details has caused the elimination of much red tape, the fixing of standards of efficiency, reduction in rates in some instances of public owned utilities and in general, better results from the various departments with corresponding general improvement in the city's appearance.

In the light of these facts there is no gainsaying that this new type of municipal law has produced benefits. Its coming and life thus far have created a new civic consciousness rarely before experienced. While there have been a few instances of seeming failure and this is within the law of average, for in all efforts there are a few failures, yet there is no record of such corruption and waste as have characterized the cities governed under the old type. Nevertheless, there are some serious drawbacks to this form. The last word in municipal management had not as yet been written. Its success primarily is due to the fact that "new brooms sweep clean." The novelty of it has brought closer attention just as a new toy replaces the older playthings. Of itself this new form has produced some incentive for officials to succeed. But inherently it does not offer something definite and final. What, then, are its defects?

One is the election of men to positions requiring administrative and executive ability. Any man, no matter what his previous situation in life may be, is eligible to seek the office. His qualifications are scarcely sought. If he can interest the public sufficiently in his cause, whether through treating, cajoling, or honest effort, he stands a good chance of election. In no sphere of human activity but in this could a barber become a commissioner of water, a house-mover a commissioner of public buildings, a carpet dealer a commissioner of public works, a dentist a commissioner of health and safety or an architect a commissioner of streets. Would any one of those business men in his civilian office have taken a man who had trained himself for a commissioner as a barber, a house-mover, a carpet salesman, a dentist or as an architect? "Ridiculous!" he would say, "I want a man who has had experience if he is to be paid." By the same token cities should not receive men who have had no training for their work and pay them handsome salaries.

Though the vast majority of commissioners have had no training in private life to fill their respective positions, many of them have latent potentialities, which in their new position offer opportunity for development and fruition. But unfortunately, in many instances where a man has been elected and held the office for a period of four years and has served his "apprenticeship," election time comes along and he loses. Then a new one comes in. He makes as many changes in the personnel of his department as he can. The public business suffers again—in fact, receives a set-back—while another commissioner serves his "apprenticeship," and so on, ad finitum. The first holder of the office perhaps lost it because of some action taken by him in his capacity as a member of the legislative body, and herein is a serious defect in this form of organic law. The commissioners are at one and the same time a law and policy making body and heads of departments. These two functions of government should be kept entirely separate. Greater permanency to the department executive with corresponding proficiency can thereby be gained. It gives the individual a greater sense of security in his position and does not require his "playing to galleries" to retain it. That is, provided, of course, he be appointed and not elected. Let the policy determining body come from the people direct through election, for they must reflect the will of their constituents. Let them determine what is needed, what is best, and then turn to the departments to carry their affairs, by a board of directors, who appoint at a commensurate salary, a general manager who understands the business. No board would for a moment trust the responsibility of its corporation into the hands of some stockholder who is looked upon as a "hale fellow well met," and whose chief ability is to draw votes. Instead, a competent man is selected and if he gives adequate service he remains. If he does not, someone who can is then selected.

This is the principle of the city manager form of government as now adopted by some hundred cities in the United States. The "principle" of it is absolutely sound. It is indeed an instrument of efficiency which gives public officials a chance to produce the most far-reaching achievements. Where the commission form fails in constituting a method, this type fulfulls practically every condition required to be a method. A charter of this kind properly drawn combines all the safeguards that a democracy demands and gives ample leeway to the official to produce the best possible results. The "principle" of it, let it be repeated, is sound.

Obviously for the best possible achievement in any endeavor as well as municipal government there must be complete synchronizing of authority and responsibility. In this particular and important feature the commission form breaks down. Each commissioner has full responsibility, but unfortunately insufficient authority. The commissioner of streets, for example, is charged with the proper construction of sidewalks. The commissioners antagonistic to him, in a desire to reduce expenses, vote to eliminate the office of inspector. The commissioner of streets realizes that an inspector is necessary to watch the contractor, but he cannot employ a man because no power to do so is vested in him, for no provision is made in the civil service rule. The result is obvious.

Major George L. Dillman, in an address before the San Francisco Association of American Society of Civil Engineers, said:

"We have a wonderful example of violation, partial accord and full accord with "The Principle," in the Panama Canal. First, Wallace tried to shoulder the responsibility under a commission whose headquarters were in Washington. He was not even a member of the commission to start with. Complete separation of authority and repsonsibility resulted. Wallace started, but he didn't get very far.

"Then Stevens took up the same load of responsibility. [illegible] had such power as

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*From a paper [illegible] League of Pacific Municipalities.

[illegible] than Wallace, [illegible] had its head [illegible] in the United States. The same [illegible] authority. Stevens [illegible] conditions under [illegible] connection with [illegible] everything in work [illegible] Colonel Goethals [illegible] I was preceded by a [illegible] My progress is somewhat due to Stevens' plan for the removal and disposal of the [illegible]

Then the responsibility was taken up by Goethals, with full authority. He was not only president of the commission, but the rest of the commission were largely his subordinates. The result was the greatest and most successful construction organization in the history of the human race.

Wallace and Stevens were sacrificed to the education of the authorities at Washington. They failed not because of lack of ability, but because of lack of authority. Goethals or any one else would have failed from the same cause. The greatness of Goethals over that of his predecessors was his application of the Principle. He insisted on having the authority before he attempted to shoulder the responsibility.

The [illegible] of a city should be composed of not less than five members and rarely, except for very large cities, of seven. This makes for the short ballot, lessens the likelihood of bitter factional quarrels and renders less [illegible] the [illegible] of business. The function of this body should be purely legislative and policy making. Each member of it should represent the entire city; this fact requiring the elimination of ward lines. Features tending to sectionalize the city should be avoided.

The Council should appoint the City Manager for an indefinite term of office. Nor should there be any limitation as to prior residence. He should be safeguarded in his position so that at least a four-fifths' or five-sevenths' vote would be required to remove him. Under him all departments should be placed. These to include the assessor, treasurer, health, fire, police, park, recreation, street, city engineer, purchasing agent, charities, municipally owned public utilities and such other administrative departments as are locally peculiar. Consolidation of departments in the discretion of the Manager should be permissible. The City Manager should recommend to the Council the salaries to be paid, but that body should have the final word in determining both the amount of and the actual fixing of the same. To leave the matter entirely in the hands of the City Manager is repugnant to the principle established by our forefathers. The spending power of a municipality should lie in the hands of the Council, because that body is directly representative of the people and of those who support the government.

In municipal charters there should be a provision requiring candidates to give to the people a statement of their qualifications for the office which they are seeking.

Let there be no civil service restrictions whatsoever. This may seem somewhat unusual, for so it is indeed. The civil service features that we have today in municipal charters have their outcome as result of the adoption by our federal government. In times past we have copied the federal law extensively. There is an historical reason for this. We have looked upon the city as a small republic or a small state and have viewed it in the same light as did educators of two and three centruies ago, who considered a child but a small being endowed with the same mind of an adult. We have learned, however, that there is a vast difference between the mind of a child and the mind of an adult: that there is a difference in quality as well as in quantity, so that education of today is based upon entirely different methods to those employed in dealing with the adult mind. Similarly conditions in a municipality differ in quality with those of the national government, and we must view them from a different standpoint altogether. Because the national government found it necessary to adopt the civil service to protect its employes, does not follow that a [illegible] under the City Manager should need the same protection. A City Manager holds his position not because of political reasons, but because of his inherent ability to do the work. He has no axes to grind nor enemies to punish. He is seeking efficiency, and those in the city's employ who have given efficiency are just as likely to hold their positions as are employes in any private corporation.

It is a well known fact that a man may pass an examination successfully and yet be an unsatisfactory individual in applying in a practical way what he can put on paper. Under the civil service such a man can be appointed and once in it is very difficult to remove him. A City Manager should have a free hand both in the employment and the discharge of employes. He should be able when necessity demands to remove them from one department to another, without being hedged by fixed rules. Probation periods do not disclose all the defects of an individual and hence any limitation which will tie a City Manager's hands simply makes his work more difficult.

There has been a tendency to create boards to carry on municipal work. We have had Boards of Health, Charities and Correction, Liquidation and Library Trustees, Theatrical Censors and the like. Save for possibly the Board of Education, which has been recognized by state law in some states as an entirely separate unit, no positive need for these bodies exists under a city manager form of government. At best they too often prove sources of dissension and quarrel and help to pile up the red tape and irresponsibility that exist in municipal administrations. The city manager charters permit the Manager to apppoint advisory groups to assist him in any problem that he may deem necessary. They work with him and not against him. His responsibility is not shifted, since they are but advisory and have no authority whatever delegated to them. Thus elimination of these boards gives greater centralization and a better opportunity for the despatch of business.

This new form of government is by no means a panacea of all municipal ills. It is founded upon the structure of human participation and interpretation, and we know that mortals are not endowed with infallibility. It has been attacked in the courts and there have been managers who failed. The fact that its bitterest opponents are principally the old line politicians is ample justification for its existence, and finally, as the progress made through the commission form of government renders null and void the stigma of James Bryce's comment, so this new type, because of its fundamental principles and the application thereof, renders Henry Bruere's statement no longer forceful.

National Emergency Public Works Board Proposed

A bill has been introduced in the Senate by Senator W. S. Kenyon of Iowa to create a United States Emergency Public Works Board, consisting of the chief of engineers of the U. S. Army, an officer of the Department of the Interior, an officer of the Treasury and two citizens. The last mentioned would be appointed by the President. The bill provides that each member shall devote his entire time to the work of the board, for which he will receive an annual salary of $5,000 per year. The board would co-operate with all federal, state and municipal agencies entrusted with the execution of any public work and would endeavor to stabilize industrial and employment conditions during the present period of demobilization and industrial readjustment by providing or stimulating increased opportunities for employment on useful public works during periods of extraordinary unemployment. The bill provides an appropriation of $100,000,000 to be used by the board as an emergency public work fund.

Overhead Charges Between City Departments for Construction.—Work done by one department of the city of Detroit, Mich., for another department is paid for at cost plus a percentage for superintendence and overhead expense This charge for four principal departments of the city is as follows:

Department of Public Works	Cost plus 15 per cent
Public Lighting Commission	Cost plus 10 per cent
Department of Park and Boulevards	Cost plus 15 per cent
Board of Water Commissioners	Cost plus 20 per cent

Selection of Service Meters*

By W. R. EDWARDS,

Assistant Superintendent, [illegible] N. J. Water [illegible]

The controlling principles involved in determining the size and make of meter should be economy and efficiency. Usually the water department furnishes the meter, and must keep the capital expense as low as possible, consequently the smallest meter that will do the work in any particular case is desirable. Fortunately the second requirement of efficiency is usually obtained by the same selection.

Oversizing is, in my opinion, a common fault, and it is better to err in the opposite direction, as in that case your attention will be directed to the error by the consumer complaining of poor service, while on the contrary, if the service is oversized in the meter used, a substantial loss may be sustained by the department in under-registration. The oversize meter will not register all the water passing through it and costs more.

Our experience, covering 20 years in time and the setting, care and handling of some 22,000 meters, is that no matter how careful we may have been, we have in the past allowed ourselves to be influenced by the opinion of property owners, mill engineers, architects, etc., with the result that much larger meters were installed than were necessary. That our judgment has been swayed is clear by our experience following the installations of the first 5 or 10 years. A careful watching of the performance of individual meters by following their registration, semi-annual tests as to sensitiveness and accuracy, watching the difference in amount of water recorded following reduction in sizes or change in type of meter on a particular service, soon made the fact clear that in many cases we had been using meters of too large capacity. This range covered the use of ¾-in. and 1-in. meters for residential service where ⅝-in. was sufficient, to factory or commercial use where from 1½-in. to 6-in. meters were being used in situations that could better be served by ¾-in. to 2-in. meters.

For the last 10 years, during which our business has developed at least 62.8 per cent and the number of meters in use has increased by 99.9 per cent, we have not found it necessary to buy many meters above ⅝-in. in size. The demands of a growing industrial section for meters of a size larger than this has been met by the withdrawal from service of meters which had previously been set larger than necessary; these being replaced by smaller meters or meters of a different type more suitable for the particular service.

Our experience has led us to establish a general rule covering residential installation, and this rule is as follows:

Up to 6 families, a ⅝-in. meter.
From 6 to 12 families, a ¾-in. meter.
From 12 to 18 families, a 1-in. meter.
From 18 to 25 or 30 families, a 1½-in. meter.

For commercial or industrial service, the size and type of meter to be used are determined after having considered all the information available as to probable quantity of water to be used and rate at which it will be drawn. Bearing in mind also in determining the size, the psychology of the water user and knowing that it is easier to increase than to decrease the size, and that such a change would leave a pleased customer, we are careful not to get an oversize original installation. The objection of the customer to the placing of a meter of smaller capacity than his judgment indicates necessary, is usually satisfactorily met by the assurance that if found necessary after trial, a larger size will be installed without expense to him.

Where the service demands a large volume at times, with the necessity of taking care of small flows either of use or leakage, the compound type of meter has been found suitable. This condition frequently arises. For example, for a small town service, where fire protection is of primary importance but where the ordinary range of draft is greater than that provided for in a Venturi meter of proper size, a compound meter, which has a current meter for larger [illegible] and a positive displacement meter for the smaller [illegible] the most suitable type. This condition is also met in [illegible] buildings where flushometers are installed, also in apartment houses and the smaller tenements, where the installation of compound meters of comparatively large size would be necessary to provide for the large flow demanded by flushometers, the use of flushometers is dis[illegible].

It is more effective and economical to install a larger service than has heretofore been the custom than to use a larger meter. Loss of head can be overcome more readily, more economically, and more effectively by using a larger service than by the size and type of meter.

Where a larger flow for short intervals is desired than can properly be provided for by the department and still give consideration to accurate registration and first cost of installation, such as filling tubs in a dyehouse or providing for the demands of flushometers, the service may be secured by the use of tanks. This shifts the burden of the extra expense of installation from the water department to the customer, but this is justifiable, in our opinion.

Our invariable rule is to use a meter of smaller size than the service to which it is attached. Installations are all made so that a meter can be changed to a different size or type readily and with little expense, in order that changes in use or unforeseen conditions may be taken care of easily and readily.

The determination of the size of the service and the size and type of the meter to be used for any consumer should be with the water department. The operator of the department does or should know what is required both for proper service to the customer and for economical and efficient service for the department.

All meters larger than 2-in. in size are installed so that they can be tested in service without the interruption of the service, and such tests are made twice yearly. All smaller meters are removed for periodical tests, the period being determined by the service which the meter is rendering, or by the requirements of the State Utility Commission, which requires that all meters must be tested after a fixed number of years of service, or after having passed a certain quantity of water, depending on the size.

More care is needed in the selection of meters for particular service. The selection should be made by a man experienced in the supplying of water and with an accurate knowledge of the mechanical qualities of meters, their limitations and possibilities. Much money can be saved a department both in installation and operating cost, and in securing a full registration of all water delivered, by proper attention to details.

Cost of Meter Testing.—The average cost of water meter testing at Detroit, Mich., for the year ending June 30, 1918, ranged from 7 ct. each for ⅝-in. meters to $3.84 each for 8-in. meters. According to the last annual report of the Board of Water Commissioners 34,294 meters were tested, the total cost being $3,444. The average costs for the different sizes, the tests being for flows full to ⅛ in., were as follows:

Size. In.	Number.	Average Per meter.
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
1	[illegible]	[illegible]
1½	232	.85
2	173	.85
3	66	3.84
4	27	3.84
6	25	3.84
8	1	3.84

Cost of Installing Meters at Detroit. During the year ending June 30, 1918, the city of Detroit set water meters at an average rate of 97 per day for 300 days. The cost of installing these meters is given as follows in the report of the Board of Water Commissioners:

Size. In.	Number.	Average labor and cartage. Per meter.	Average material, including meter. Per meter.	Average cost. Per meter.
⅝	[illegible]	$0.40	$[illegible]	$[illegible]
¾	1,135	.40	9.40	9.80
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	$[illegible]	[illegible]	[illegible]

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*From a paper presented before the New York Section of the American Water Works Association.

Saving Effected by Detroit Water Board by Using Excavating and Pipe Laying Machinery

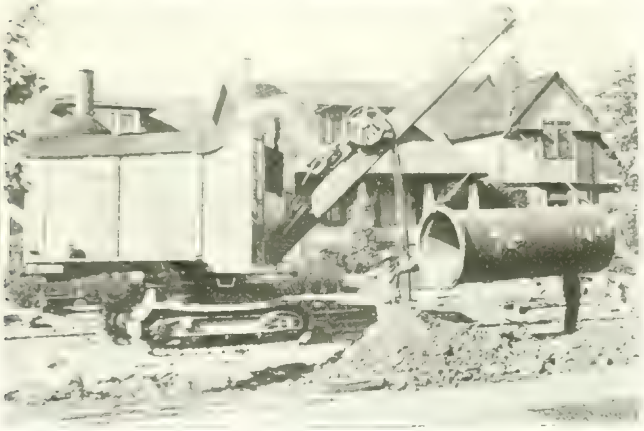
[illegible] conditions of the last two years the Board of Water Commissioners of [illegible] distribution system [illegible] laid 111½ miles [illegible] In carrying out this work [illegible] In fact [illegible] of the saving offered by [illegible] that the board [illegible]

Trenching and backfilling machines were first employed by the Detroit Water Department in 1916, and in 1917, and their value was so fully demonstrated that more equipment was purchased. The machines now in use by the [illegible] include:

[illegible]
[illegible]
1 Trench digger, capacity 33 in. wide by 10 ft. deep.
[illegible]
2 Trench diggers, capacity 72 in. wide by 10 ft. deep.
[illegible]
[illegible]
[illegible]
1 Air Compressor
[illegible]
1 Concrete Breaker, hammer 700 lb.
1 Pulsometer with boiler.
[illegible]
12 Power driven diaphragm pumps.
[illegible]

Trenching Machine Digging Ditch 72 in. Wide, for 42 in. and 48 in. Pipe.

[illegible] 18 in. pipe by hand at [illegible] the work at [illegible] ft. of 42 in. and [illegible] a saving of over [illegible]



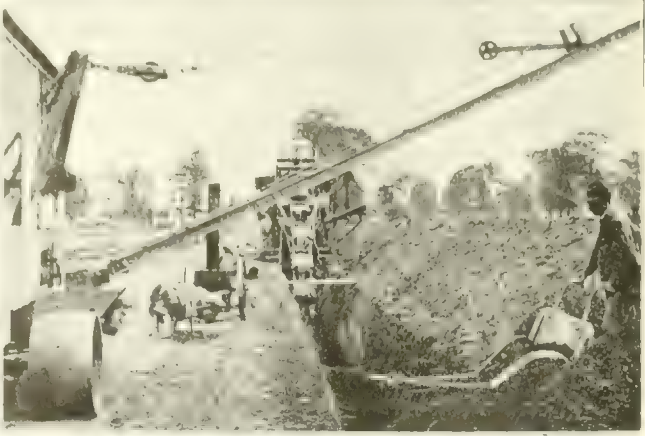
Lowering 48 in. Pipe, Weighing 10,900 lbs., with Steam Crane.

Employing hand labor, 14 men were required to lower pipe and handle the derrick at a cost of $6.70 per pipe. The steam crane [illegible] $1.88. About [illegible]

In his report for the year ending June 30, 1918, Mr. Geo. H. Fenkell, General Manager of the Water Department, gives the following table showing the saving expected by the use of machines:

	All hand [illegible]			Dug and backfilled by machine			
[illegible]	[illegible]	Total [illegible] cost	[illegible] per ft.	[illegible]	Total [illegible]	Cost per ft.	Saving [illegible] per ft.
[illegible]	59,238	[illegible]	[illegible]	60,107	$21,118	$0.[illegible]	$0.21
[illegible]	[illegible]	19,108	[illegible]	31,00[illegible]	12,[illegible]	10	18
1[illegible]	[illegible]	[illegible]	1.11	5,863	[illegible]	1[illegible]	.62
[illegible]	[illegible]	1,291	1.62	13,011	[illegible]	[illegible]	.63

On the 42 in. and 48 in. pipe lines a material saving was effected by the use of mechanical appliances to replace hand labor. The following are some of the most striking instances, the figures being based upon the prevailing scale of wages:



Backfilling on Ditch 30 in. Wide, for 6 in. and 8 in. Pipe.

Hand backfilling cost 9 ct. per foot for a 30 in. ditch for 6 in. and 8 in. pipe while the machine backfilling cost 3½ ct. per foot. These machines backfilled about 600,000 lin. ft. of 30 in. to 72 in. ditch during the year.

Labor per foot in laying 42-in. and 48-in. pipe will average $8.70 by hand, and $3.50 by machinery; caulking averages $1.32 per joint by hand and $0.49 using pneumatic hammers; handling and lowering each pipe by hand labor averages $6.70 and $1.88 using the steam crane. Backfilling ditches on small lines costs about 9 ct. per lineal foot by hand and 3½ ct. per foot by machine.

Employment for Civil Engineers

State and municipal authorities, corporations and individuals who now have, or expect in the near future to have, need for the services of professional engineers are requested to immediately communicate their wants to the Engineering Societies Employment Bureau, 33 W. 39th St., New York City. This bureau is maintained by the four national societies of civil, mining, mechanical and electrical engineers. A number of engineers who have been serving in the army or in Government capacities during the war are about to be released from their present duties. It is the desire of the engineering societies to place these engineers in touch with contemplated projects as early as practicable. In the present emergency the lack of openings for civil engineers has been observed and it is to provide, if possible, for these men that this notice is issued by the Bureau.

Hydro-Electric Development in Canada Produces 2,300,000 HP.—According to a recently completed report of the Dominion Census Bureau the developed water power in Canada amounts to 2,305,000 HP. Of this total 1,727,000 HP. is from central electric stations producing electricity for distribution and sale, 352,000 HP. is from plants owned and operated by pulp and paper companies and 225,600 HP. is from plants of other manufacturing and industrial establishments. The average horsepower for the entire dominion per 1000 population is 276.

Removal of Iron and Manganese From Water Supply of Wausau, Wis.

Removal of iron and manganese from the water supply of Wausau, Wis., by aeration and filtration is recommended by Mr. W. G. Kirchoffer, Consulting Engineer, Madison, Wis., in a report submitted last December. Experiments on five wells led to the conclusion that for these wells the water could be greatly improved by reducing the iron to an average of 0.12 parts per million and the manganese to an average of 0.60 parts per million by the use of air-lift pumps. The report states that there are 11 more wells which according to the preliminary tests should give as good results as these five did, so that an average of 2,832,000 gal. per day could be obtained by the use of air lift pumps. This water if sufficient in quantity would be satisfactory without treatment, but a filter plant will have to be constructed to be operated in conjunction with this untreated water.

The test of the wells for iron manganese shows that the remaining 19 wells contain from 1.5 to 15 parts per million of iron and from 1 to 3 parts per million of manganese. While it is quite possible that the continuous operation of all of these wells by air lift might reduce the iron and manganese to a small extent, yet it could not be expected to reduce them to such an extent as to make a water entirely satisfactory for domestic use.

Wells yielding a water high in iron and manganese should be separated from the other wells and the water filtered even though the water from the best wells is used without filtering. The two mixed together would give a water of such low content of iron and manganese that it would scarcely be noticed. At some future date if thought advisable, the filtration system could be extended to treat all of the water. If reservoirs and filters are constructed in accordance with well accepted designs it will be comparatively easy to vary the treatment in the future if occasion should demand it, or better processes be discovered.

Kind of Filters to Be Used.—A water which will most of the time be entirely free from iron and manganese can be obtained by passing the water through sand filters, treated with manganese sulphat and sodium hydroxide properly oxidized. At times there are likely to be some of these substances present which may be due to fluctuations in the level of the river, rainfall, variations in pumpage or to other unknown causes. It cannot be expected, however, that any form of treatment will remove all of these elements completely all of the time. This conclusion is based upon the tests made both at Wausau and in the Hygienic Laboratory at Madison on the filtration of this and similar waters through plain and manganese treated filters. As the result of a large number of experiments it was found that simple aeration of a water low in iron and manganese even when settled removed little or no iron; sedimentation alone apparently does not effect the presence of iron appreciably.

Aeration, sedimentation and filtration through a plain sand filter when new removes but a small percentage of these substances. Experiments with the use of chemicals such as lime, soda ash and alum were not entirely satisfactory as none of them showed a complete removal of either iron or manganese. Such treatment, even if satisfactory, would be extremely expensive.

Coke contact filters appear to reduce the amount of iron, but slightly, and manganese, not at all, although they may effect a change in the oxide of iron and manganese so as to make these more readily removable by the filter. The use of the aeration nozzle appears to coat the coke with a deposit of iron and manganese oxides much more readily than when using a submerged outlet. The untreated filter removed 23 per cent of the iron and 12.3 per cent of the manganese. The treated filter removed on the average 40 per cent of the iron and 52.7 per cent of the manganese.

The last two tests made after the nozzle was added showed a removal of 55 per cent of the iron and 95.46 per cent of manganese.

The only process that has promise of success and seems to improve the longer it is worked, was the one in which the oxides of iron and manganese played a part in their own removal. This statement is in accord with the experiments of water plants in Illinois and experiments in the laboratory of the State Water Survey of Illinois.

Iron and manganese no doubt occur in the water as an oxide and sulphate. The presence of a large amount of carbonic acid in the raw water and its liberation by aeration through the nozzle or contact with other substances would indicate the truth of this theory.

A small filter was set up in the laboratory and treated with manganese sulphate, sodium hydroxide and an oxidizing agent such as potassium permanganate, or sodium hypochlorate after which city water was passed through it with the result that a material reduction in the manganese was made. The same results, though not in as marked a degree was obtained on the experimental plant at Wausau and later at Wausau on the laboratory filter.

By operating the experimental plant at Wausau continuously for two months at a rate of about 1 gal. per minute, the filter became automatically coated with the oxides of iron and manganese and effected a practically complete removal of the manganese. Full sized filters would give more uniform results and no doubt be more efficient.

Another very interesting experiment was performed at Wausau to show that the restoring of the higher oxides of iron and manganese is responsible for their removal. The laboratory filter previously treated with mananese, was drained out, then filled with a 2 per cent salt solution. An electric current from four dry cells was then run through the filter for 14 hours after which the salt solution (now a sodium hypochlorite) was drained out and city water applied with the result that 92½ per cent of the iron and 83½ per cent of the manganese was removed. A test previous to the salt solution treatment, removed 55½ per cent of the iron and none of the manganese. The plain sand filter was treated with the solution drawn from the manganese filter with the result that 91 per cent of the iron and 45.8 per cent of the manganese were removed, so that it was very apparent that the electro-chemical treatment was responsible for the greater removal.

These results are in accord with those obtained at Mt. Vernon, Ill. (See University of Illinois Bulletin, Water Survey Series No. 13; also experiments of Dr. H. Luhrig of Breslau, Germany. See water purification by Elms, p. 449). At Mt. Vernon and the Anna State Hospital, calcium hypochlorite were used at the rate of .2 to .3 parts per million of available chlorine. The experiments of Dr. Luhrig were along similar lines in which a sodium permanganate was used to coat the grains of the filter.

Continued application of the hypochlorite of sodium permanganate would not appear to be necessary after the filters had once got into good working condition. At least this was tried at one of the plants above mentioned and the removal continued just the same.

Mr. Kirchoffer is of the opinion that the use of sodium hypochlorite would be preferable to calcium hypochlorite (bleaching powder) for the reason that it will not produce a sludge which tends to clog the filters.

He recommends the filtration plant be provided with the necessary apparatus to produce sodium hypochlorite by the use of common salt and an electric current. The place and rate of application and the interval between applications are matters which will yet have to be worked out. These are details of operation that have to be worked out in any plant. The rate of filtration will depend upon the amount of iron and manganese in the water to be treated and the degree of oxidation that is obtained when restoring the manganese oxides. According to present information [illegible] the filter appears to be about correct.

Type of Filter to Be Used. The filter plant can be constructed either of the gravity or the pressure type, but according to present observations, preferably the gravity type. This point can best be settled after it is decided whether or not the air lift pumps are to be used and taking into consideration relative costs. The filter should be constructed in accordance with standard methods and designs, but with a filter medium chemically treated so as to [illegible] the [illegible] oxides of manganese and the [illegible] for removing these [illegible].

From the experiments, made both in the laboratory and at Washington, it was demonstrated that both gravity and pressure filters [illegible] will remove a large per cent of both iron and manganese.

The pressure filter has the advantage that it is somewhat cheaper and possibly [illegible] that it can be put on the discharge main from the pumps to the city and so far as it [illegible] would need no secondary pumping.

However, the gravity filter has the advantages that it can be handled with more convenience, in that the operator can see more closely just what is going on and thus make adjustments [illegible] and readily. If the material of the filter needs renovating it can be done much more readily than in a pressure filter. The information at hand would indicate that the gravity type of filter would be the best type.

It is very evident that the process of removal of these substances is extremely sensitive to any slight change in the operation of a filter. That is, if the surface of the sand is disturbed in the slightest degree, an increase in the amount of iron and manganese will be found in the effluent.

Cost of Installing Service Pipes at Portland, Ore.

All service pipe installations at Portland, Ore., are made by the forces of the Bureau of Water Works of the Department of Public Utilities. This policy, states the last annual report of the Department, has been a great improvement over the old system of allowing services to be installed by private parties. A more uniform location of the services and a standard class of material has been obtained and in many instances a better class of workmanship has prevailed. The cost has been standardized, and while in some instances the cost to the property owner may have been a little higher the average has been lower and the general conditions better, as mentioned above. Furthermore, the property owner has the Bureau's guarantee to keep the service in repair for 10 years.

The following table shows the rates charged for laying and constructing such service pipes by the Bureau of Water Works:

Size of service.	Unpaved street.	Paved street.	Cost of each additional foot of length: Unpaved street.	Cost of each additional foot of length: Paved street.
½-in.	$14.00	$26.50	$0.18	$0.68
¾-in.	16.00	28.50	.20	.70
[illegible]	[illegible]	[illegible]	.2[illegible]	.75

In case it becomes necessary to cut concrete sidewalks and repair same for the purpose of installing curb cock, an additional payment of $5 is required.

Cost of Repairing Meters at Detroit, Mich.—During the year ending June 30, 1918, the Water Works Department of Detroit, Mich., repaired 9,528 water meters. Of the total 1,723 had been damaged by hot water and 4,088 by frost. The unit cost of the meter repairs, according to the report of the Board of Water Commissioners, was as follows:

DAMAGED BY HOT WATER.

Size. In.	Number.	Average labor. Per meter.	Average material. Per meter.	Average cost. Per meter.
[illegible]	[illegible]	$ 1.38	$ .17	$ 1.55
¾	678	1.48	.24	1.72
1	193	.39	.07	.46
1½	19	3.95	1.43	5.38
[illegible]	[illegible]	[illegible]	1.10	5.91
[illegible]	[illegible]	[illegible]	[illegible]	13.00

DAMAGED BY FROST.

Size. In.	Number.	Average labor. Per meter.	Average material. Per meter.	Average cost. Per meter.
[illegible]	[illegible]	[illegible]	[illegible]	1.68
[illegible]	[illegible]	[illegible]	[illegible]	1.75
[illegible]	[illegible]	[illegible]	1.10	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

BECAUSE OF WEAR AND TEAR.

Size. In.	Number.	Average labor. Per meter.	Average material. Per meter.	Average cost. Per meter.
⅝	2,519	1.42	.27	1.69
[illegible]	[illegible]	[illegible]	[illegible]	1.88
1	214	1.92	.63	2.55
1½	51	3.57	1.43	5.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	6.30
[illegible]	[illegible]	[illegible]	[illegible]	15.91

Protecting Fire Hydrants Against Freezing in Winnipeg

Despite the severe climatic conditions at Winnipeg, the cold in winter sometimes dropping to 40 or 45° below zero, the firemen of this city have never found a hydrant out of commission when required, through being frozen or from other causes. This desirable condition, states Mr. Thomas H. Harvey, operating superintendent of waterworks, in the Quarterly of the National Fire Protective Association, has been brought about primarily by a system of daily inspection in the downtown portions and congested areas, tri-weekly inspections in the adjoining districts, bi-weekly in the outer portions of the city.

All hydrants immediately after use in winter season are repacked with a composition of tallow and hemp packing placed in the stuffing box in hydrant head; otherwise the operating nut would be frozen solid and the hydrant placed out of commission. Occasionally, through a faulty drip, the water will rise in the post, when a steam boiler is used for the purpose of forcing steam into the post to thaw it out.

When a hydrant is found out of repair, the first brigade is notified at once, and when placed in commission the brigade is informed. All repairs to hydrants are treated as emergency jobs, and workmen stay until repairs are completed.

Hydrant repairs are divided into two classes, light and heavy. Light repairs consist of repacking, renewing bolts or nuts, and renewal of parts which can be made without digging out the hydrant. Heavy repairs are occasioned through foreign matter being drawn into the hydrant, such as sticks or stones which have been left in mains at time of construction or the breaking of post or valve. It is most essential that in laying water mains it should be the duty of some man to inspect each pipe as it is laid, and at night when men lay off work to block the end securely to prevent children from throwing stones in the pipes.

Hydrants are placed at approximately 300-ft. intervals on all new mains laid, the waterworks receiving an income from the city at large of $30 per hydrant per annum to offset the water consumed and the maintenance of the hydrants.

Considerable trouble was experienced in past years, owing to unauthorized persons operating hydrants, using at times alligator wrenches or large monkey wrenches, and in doing so stripping the edge off the operating nut, which is pentagonal in shape. A by-law was passed, making it a misdemeanor for any one (except the fire brigade) to use a hydrant without first securing the permission of the department.

There are in use in this city at this time 2,360 hydrants and 4,005 valves on domestic service. Valves are inspected the same as hydrants, as it is necessary in case of a break during a fire to localize the break by shutting off the least possible length of main.

Valve repairs are far more frequent than hydrants, caused generally from broken bolts, broken spindles or foreign matter such as sand, stones or sticks blocking valve so as to prevent it being properly closed when required.

The fire service waterworks system or high pressure which is supplied with water from the Red River receives the same close attention as the domestic system, there being 158 hydrants and 298 valves.

Water mains in this city are laid at an average depth of 7 ft. 6 in., and in spite of the intense cold, frozen mains are almost unknown. Last year a main in an outlying district was found to be so nearly frozen that only a small stream could be secured at the hydrant. The hydrant was left open, when the water gradually cut the ice away and in time freed itself.

Asks Joint Control of Rails and Water Ways by U. S.—The declaration of principles adopted Feb. 7 at the 14th annual meeting of the National Rivers and Harbors Congress recommends Federal supervision of water transportation, enlarged jurisdiction of the interstate commerce commission over water and rail rates, and the improvement of all navigable streams upon which commerce could be established.

Needed Revision of Public Improvement Bond Laws*

By I. E. DIERDORFF,

Davenport, Iowa

The matter of good bond laws has been, and [illegible] subject almost wholly neglected by municipal officers and legislators. With the dawn of peace it has become necessary for the officials of our municipalities to turn their attention to improvements, the construction and installation of which has been postponed—and properly so—until the close of the war. Simple, desirable and workable laws under which municipal improvements may be financed is a most important subject and one which deserves the intelligent and serious attention of every municipal officer and student of municipal affairs.

There is now a widespread movement which contemplates the enactment in each state of a single, uniform and general bond law. The plan should immediately commend itself to every one interested in correct municipal financing. In Iowa we have a multiplicity of laws which is both bewildering and useless. In making loans the governing bodies of our cities and towns should not be obliged to proceed in various ways. There can be no good reason why a city council must operate in one way to secure funds to extend the water works system and be compelled to proceed in an entirely different way under a different law in order to secure funds with which to erect a city hall. Whenever bonds are issued, money is borrowed and money is repaid. Multiplicity of laws which cover the same subject is needless, confusing and cumbersome.

Most legislation is obtained because some one prepares the proposed law in advance and then applies sufficient force to drive it on the statute books. This is not said in criticism of the legislature or any member thereof, but it should be appreciated that if corrective legislation is to be adopted, if the municipalities of Iowa are to have modern bond laws, suited to their needs, some one must initiate and urge their adoption.

In this respect the Iowa League of Municipalities occupies an admirable position. Its only interest is the welfare of the cities and towns of Iowa and its members should hold as an ideal the complete revision of our bond laws into a simple, single and uniform act.

It has long been the practice in Iowa to hastily enact a new law, without regard to its bearing on existing statutes, whenever a new situation arose or an existing law was found inadequate. Perhaps, a particular statute or an amendment to an existing statute was hastily enacted to meet a new situation or a new need in one, or at the best, a few towns or cities in the state. No thought or study has been given to the matter of securing a single, uniform method of procedure in authorizing bonds of all kinds. As a result we have in our state four bond laws for water works, two for gas works, two for electric lighting plants, three for city halls, three for bridges, two for sewer outlet and purifying plants, etc. Each law has but one purpose—a method by which a municipality may secure needed funds—yet each law has different requirements with which the municipality must comply.

The principle of limited tax rate bonds should be discarded. Each municipality should be given power to levy a tax sufficient to pay its bonds, both principal and interest, as they mature. Every good citizen of Iowa and surely every municipal official is intensely interested in placing the investment value of Iowa municipal bonds on the highest possible plane so that our bonds may enjoy a high reputation among investors and in this way enable the municipalities to borrow money on the most advantageous terms. A limited tax rate is not an advantage, but a loss to the municipality. In issuing bonds supported by taxes levied at a limited rate, the city council only obligates itself and its successors in office to levy the tax for a stated period and apply the proceeds in payment of the bond issue. The owner of the bonds can look only to the integrity of the council in properly levying the tax and properly applying the proceeds. A decrease in the valuation of the taxable property will also decrease the city's means of retiring its bonds. It has been the popular idea that limited tax bonds curb the power to incur debt and act as a safety valve on councils in levying taxes in payment. In practice such laws promote extravagance and assist materially in piling up debts for future generations to pay. In a recent instance one of our principal cities needed [illegible] for a certain improvement. The law gave the city ample authority to incur the debt, but only the right to levy a limited tax to pay it. As a result this city is obliged to pay a high rate of interest for the money for an average period of six years. If the city had authority under our laws to levy taxes sufficient to pay the bonds, the entire issue could easily have been paid in two or three years at great saving to the taxpayer in interest. Assuredly it cannot be correct financing to compel a city or town to spend 20 years in repaying money borrowed to install a sewer outlet and disposal plant; yet that is precisely the situation in a very large majority of cases in Iowa because not more than 5 mills may be levied in payment of bonds issued for this purpose.

In issuing limited tax bonds the municipalities of Iowa are paying for possible contingencies because limited tax bonds always bear a higher rate of interest than general obligations. While bonds which are a direct obligation enjoy a wide market, the buyers of limited tax bonds are few and practically able to dictate their own terms. The limited tax is by no means a benefit to any municipality. Our cities and towns should have full power to levy sufficient taxes to repay money which they borrow. Let there be limitations on the incurring of debt, but none on payment.

Nearly all municipal industry bonds in Iowa are issued under the provisions of sections 1306b et. seq. of the 1913 Supplement to the Code of Iowa. Section 1306e provides that a majority vote is sufficient to authorize the issuance of water works, gas works, electric light and power plant, heating plant or sewer bonds "provided said affirmative vote be as large as a majority of the votes cast at the last preceding municipal election." This unusual provision has made it almost impossible to authorize bonds for water works, electric lighting plants, etc. Under this statute it is not a question of the majority of the voters favoring the issuance of bonds, but rather a question as to whether the last preceding regular municipal election provided a contest which produced a very heavy vote. This law has worked an injury in a large number of cases where the vote clearly indicated that the citizens favored the improvement, but the proposition failed because the affirmative vote was not equal to a majority of the votes cast at the last preceding municipal election. As a matter of fact in two recent cases in this state the election unanimously favored the proposition, yet it failed. This law is unfair to the municipalities. The result of the election should not depend upon the number of votes cast at a previous election. The majority necessity should be clearly stated, either a simple majority as required in most of our sister states or a three-fifths majority. A recent decision of our Supreme Court involving this statute makes it practically unworkable.

Corrective legislation is urgent. Proper revision of the statutes will greatly benefit our cities and towns. But even the revision of these statutes would be but a continuation of the piece work and patchwork method of legislation which has been the custom altogether too long in our state. The cities and towns of Iowa should look to the future and provide now a firm foundation for all municipal bond issues which can only be had by the enactment of proper laws which provide the necessary elements of a sound and certain procedure.

Folding Sectional Maps of Water Distribution System.—District foremen of the Water Department of Portland, Ore., are furnished with a folding sectional map of the distribution system, on a scale of 200 ft. to the inch. Prints are made from the tracings as needed and are folded into such shape that they can be slipped in and out of a cover designed to hold them.

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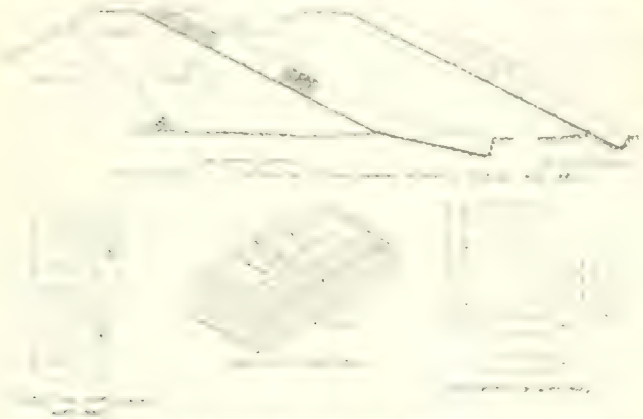
*From American Municipalities.

Methods and Cost of Riprapping Embankment by Wire Bag Method

During the winter and spring of 1916-17 [illegible] were constructed at Lake McMillan, the storage reservoir for the Carlsbad Project of the U. S. Reclamation Service. One of the features of Spillway No. 1 is an embankment built to protect the tracks of the Atchison, Topeka & Santa Fe Ry. The toe of this embankment had to be protected against velocities of from [illegible] to about [illegible] second feet. In the absence of suitable foundation for concrete it was decided to [illegible] the embankment [illegible] second [illegible] with [illegible] bags filled with rock. The method of doing this is described by Mr. [illegible], Project Manager, in the Reclamation Record. The accompanying drawing shows the method of placing the wire bags. Details of the individual bags and the special tools used in their manufacture also are shown.

The wire bags were composed of two [illegible] sections [illegible] wire [illegible] sewed together with No. [illegible] wire. The wire is [illegible] galvanized [illegible]. The weight of wire for one bag was 70 lb. The capacity of bag was [illegible].



Sections of Dike Showing Method of Placing Wire Bags. Details of Wire Bag and Special Tools for Its Manufacture.

The bag material was cut and sewed in the shop into the [illegible] shown in the right hand corner of the drawing, then folded together flat, and hauled to the work. The bags were then sewed into rectanguar form with the lid loose. The bags were set in a horizontal row in place and filled directly from the rock wagons. The labor of filling the bags proved to be less than to lay riprap of the same thickness.

Care was taken to have all rock next to the wire mesh of greater dimensions than 6 by 6 in. Since this is a relatively small sized rock, much rock is available for bag work and would be too small for riprap.

After the bags were full the top was closed down and sewed securely on the front and two sides. The bags were also tied to each other along these edges, thus forming a continuous mat. Quarrying and loading on this job was charged to another feature as excavation.

Besides the 181 bags placed on spillway No. 1, 78 bags were placed as protection at the toe of spillway No. 2. The costs given below are based on a total of 259 bags.

[illegible]

11 lin. ft. of 30-in. wire mesh

[illegible]

Federal Projects for Furnishing Work for Soldiers

In his pamphlet, "Public Works or Public Charity," issued recently by the War Committee of the Union League Club, of Chicago, Prof. H. G. Moulton, has the following to say regarding Government work as a means for furnishing buffer employment to soldiers and war workers:

Among the Federal projects, reclamation in its various forms is of first importance. It is easy to assume that great numbers of laborers can easily be employed in reclamation work; and large numbers could indeed be employed if enormous appropriation were made for the purpose. It is important to point out, however, that an appropriation of $500,000,000 for Federal reclamation work would give employment at living wages to about 166,000 men for a year. (This figure is based on the cost records of the United States Reclamation Service.) It may be of interest to note that 10,000 men is the highest that has ever been employed in Federal reclamation projects in any one year. Now it is not inconceivable that an appropriation of $500,000,000 for reclamation projects might be made. It is utterly inconceivable, however, that the entire expenditure could be made intelligently in a single year. The reclamation of swamps and cut-over lands, for instance, requires the most careful engineering and agricultural surveys, if we are to make sure that the areas reclaimed will be those which yield the largest return for the smallest outlay. The same holds true for flood control, irrigation, what not. It would be nothing short of a national calamity if, in an excess of zeal, public employment should degenerate into a "make-work" program regardless of the social value of the work performed.

It would be particularly unfortunate, for instance, if we should engage upon an extensive program of river and canal development without the most careful preliminary study of the creative advantages to be derived from an expenditure upon waterways. This is true, whether river and harbor and canal appropriations be made on the old "pork barrel" basis or in accordance with the most approved principles. When such a man as M. Colson, eminent French authority on transportation—Counselor of State and Director of Roads and Bridges of France—has demonstrated that the canal systems of France and Germany annually result in a heavy economic loss to those countries, it is highly important that we make a thoroughgoing analysis of the entire transportation problem before we proceed to make enormous expenditures on waterway development.

Photographic Reproductions of Records of Water Distribution System.—Rectigraph atlases are employed by the Bureau of Water Works of Portland, Ore., to save wear and tear on the main atlas record of the distribution system. The main atlas consists of a series of blue print white cloth sheets, each covering one-quarter section on a scale of 100 ft. to the inch. The rectigraph atlases are made of 14-in. x 18-in. photographic reproductions of the original atlas sheets. Copies of the smaller atlas are furnished to the commissioner's office, the engineer's office, the general foreman and the permit clerk. Corrections and additions are made free hand on the rectigraph atlases, and as soon as one sheet becomes unsightly it is replaced by an up-to-date rectigraph print.

Cost of Water Main Construction at Detroit.—The following table from the report of the Board of Water Commissioners of Detroit, Mich., shows the unit cost of labor and material for constructing water mains during the year ending June 30, 1918.

Size. In.	No. of feet.	Material, etc. Per lin. ft.	Labor. Per lin. ft.	Overhead expense. Per lin. ft.	Total Per lin. ft.
6...	316,864	[illegible]	$0.46	$0.19	$ 1.50
8...	173,641	[illegible]	[illegible]	.20	1.75
[illegible]	1,318	[illegible]	.72	.28	2.22
12...	37,116	[illegible]	[illegible]	.28	2.86
16...	10,023	[illegible]	[illegible]	.37	4.21
24...	23,418	5.35	3.15	1.19	[illegible]
36...	15,188	[illegible]	3.86	1.46	15.09
42...	[illegible]	13.48	3.62	1.39	18.49
48...	12,378	17.18	3.50	1.33	22.01

Gross Bonded Indebtedness and Public Improvement Expenditures of American Cities

The accompanying tabulation, taken from U. S. census figures, shows the gross bonded indebtedness of 30 largest cities of the United States, arranged in order of population and the per capita expenditures for public improvements during 1917:

	Gross bonded indebtedness.	Per capita expenditures for public improvements in 1917.
New York	$262.02	[illegible]
Chicago ..	47.55	12.63
Philadelphia ..	89.31	10.55
St. Louis .	33.50	8.90
Boston	170.28	4.55
Cleveland .	119.01	12.15
Baltimore	159.86	5.39
Pittsburgh	113.67	9.51
Detroit ...	55.14	21.06
Los Angeles ..	110.67	19.40
Buffalo	93.14	[illegible]
San Francisco	101.81	15.13
Milwaukee ...	45.46	11.42
Cincinnati	201.99	8.89
Newark	148.51	9.66
New Orleans .	131.28	7.86
Washington ..	17.04	8.54
Minneapolis ..	84.96	11.41
Seattle ...	135.40	16.24
Jersey City ...	117.14	2.28
Kansas City .	56.01	14.47
Portland ..	111.28	6.75
Indianapolis ..	28.22	10.77
Denver	[illegible]	2.17
Rochester	91.80	10.04
Providence ...	97.09	7.02
St. Paul	79.15	8.96
Louisville	61.39	6.29
Columbus	112.38	7.48
Oakland	48.18	6.16

South Dakota Supreme Court Reaches Important Bond Decision.—Credits of cities and counties in South Dakota will be immensely improved under the decision of the South Dakota Supreme Court in the case of the National Surety Co. versus Starkey as treasurer of Hughes County in which the court held that county, city, state and school securities were not taxable and that the legislature had no power to make laws for this purpose. Bonds issued by the state or owned within the state are held not taxable under state laws. The suit involved $25,000 worth of bonds of the Sioux Falls water works, $15,000 worth of Aberdeen sewer bonds and $10,000 worth of Webster City school bonds. The results of the decision will permit the readier sale of all such securities on the outside markets.

New York City Subway Engineers Reinstated.—The 339 engineers of the Public Service Commission of New York City who were summarily discharged on Dec. 30 because the Board of Estimate in its budget had made no provision for their future salaries, have been reinstated. On Jan. 31 the Board of Estimate reversed its action and allowed an appropriation sufficient to maintain these engineers for February and March, the remaining two months of the current quarter.

Convention of the Indiana Sanitary and Water Supply Association.—The 11th annual convention of the Indiana Sanitary and Water Supply Association will be held at Indianapolis April 9 and 10. Approximately 250 city officials, health commissioners and water works representatives constitute the organization. Dr. W. F. King, assistant secretary of the State Board of Health, is president of the association.

Five Ohio Cities Will Start Work at Once on $20,000,000 Worth of Public Improvements.—Reports made public on Feb. 2 show that five of the largest cities of Ohio will start construction shortly on $20,000,000 worth of public work as a part of the "do it now" state wide program to provide work for the unemployed. These figures came from Cleveland, Cincinnati, Toledo, Akron and Columbus.

Commission Government for Maryville, Mo.—By a vote of 451 to 151 the citizens of Maryville, Mo., have adopted the commission form of city government.

Watering Back-Yard Gardens

The following useful suggestions on the application of water to gardens are taken from a pamphlet, "War Gardening and Home Storage of Vegetables," issued recently by the National War Garden Commission.

A plentiful supply of moisture is essential. If there is not sufficient rainfall the moisture should be provided by watering the garden. In doing this it is better to soak the ground once a week than to sprinkle every day. Late afternoon is the best time to sprinkle. To moisten the surface is not enough. There must be a thorough wetting. If pipe connections are available a garden hose is the best means of watering. One of the most satisfactory methods is to open small furrows between rows and allow water to run into these trenches, raking the earth back into place several hours later and making a mulch, after the water has thoroughly soaked in. The sprinkling pot will serve if hose is not available, but it more laborious. Overhead sprinklers are very satisfactory. They consist of pipes mounted on supports extending the length of the area to be watered. Holes are drilled at intervals of 3 to 4 ft. and small nozzles are inserted which yield a spray-like misty rain when the water is turned on. By turning the pipes and also changing the position of them it is possible to water an area of any size. In home gardens proper drainage is often disregarded. Drainage improves the soil by allowing air to enter; by raising the temperature of the soil; by rendering the soil more porous and granular; by enabling the roots of plants to grow deeply into the soil and by allowing earlier cultivation in the spring. Blind ditches, partly filled with stones or other material covered with soil, or open ditches, will be found satisfactory for the home garden. They should be along the lowest level of the garden, and have suitable outlet. Lacking an outlet, lay tile 12 in. below surface of garden, slanting toward a hole 10 ft. deep and 5 ft. across, in center of garden. Fill this, two-thirds to top, with stones, covering stones with clay and covering the clay with loam.

Mexico Proposes Construction of 3 Irrigation Projects.—In connection with other reconstruction measures proposed for the Republic of Mexico, Pastor Ronaix, Secretary of Interior Development, City of Mexico, has asked for the appropriation of the sums necessary to establish irrigation systems in three of the most fertile valleys of Mexico. For one project in Chihuahua it is proposed to use water from the Elephant Butte dam, on the American side of the border

State Legislature Promises Legislation for Public Work.—A resolution was introduced in the Illinois Senate on Feb. 7, urging every municipality in the state "to take immediate steps to start work at once on public improvements coming properly within their sphere." The resolution further states that the legislature will pass whatever legislation necessary to assist in making such improvements.

One City Manager for 3 Cities.—A bill may be introduced in the Illinois State Legislature to allow contiguous cities to unite under the borough plan of government. Such a law would permit Moline, East Moline and Rock Island to have one city manager, a plan which is now being discussed in those municipalities.

Ohio Engineering Society and Licensing Engineers. At its recent annual convention the Ohio Engineering Society voted unanimously in favor of licensing engineers. It is expected that a bill for this purpose will be presented at the present session of the Ohio Legislature.

Convention of Illinois Section Am. W. W. Assoc.—The 11th annual meeting of the Illinois Section of the American Water Works Association will be held at Urbana, Ill. March 25 and 26. G. C. Habermeyer, acting chief, State Water Survey, Urbana, is Secretary.

Cost of Pumping at Detroit, Mich.—The cost of pumping water at the water works of Detroit during the year ending [illegible], was as follows:

	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	08	.07
[illegible]	[illegible]	11	.20
Total	[illegible]	[illegible]	[illegible]

The above figures do not include interest and depreciation. The pumping engine records show a station duty of [illegible] ft. lb. per [illegible] of coal consumed, a decrease of [illegible] per cent from the preceding years. This decrease is accounted for by the inferior quality of coal received. An average of [illegible] gal. of water was pumped per pound of coal.

Personals

N. G. Moss has been appointed [illegible] manager of the Mil[illegible] [illegible] Association.

A. C. Caser has resigned as water commissioner of Dallas, Tex., to accept a position as purchasing agent of the State Penitentiary System.

Walter Lander has resigned as city manager of Yoakum, Tex., to accept a similar position at [illegible], Fla., at a salary of [illegible] per year.

Thomas J. Lynch of [illegible], Pa., has been renominated [illegible] to be a member of the Pennsylvania State Water Supply Commission.

A. Takayama, president of a large hydraulic engineering company of [illegible], Japan, is in America studying the development of [illegible] in the United States.

William Lawton, Jr., for the past eight years assistant superintendent of water works at Richmond, Va., has been appointed engineer in charge of all gas and water mains and [illegible].

Albert Krell, Cincinnati, O., has been elected president of the Lake Erie-Lake Michigan-Miami Deeper Waterways Association and Avery M. Groves, Fort Wayne, Ind., has been elected secretary.

E. Earl Glass has resigned his position with the County Road Department of Los Angeles County, California, to take the sales management of the Reliance Irrigation Meters for the Hydro[illegible] of Los Angeles, Cal.

Lester E. Armstrong has accepted a position as advisory engineer with the Powdered Coal Engineering & Equipment Co. of Chicago. Prior to his service in the air branch of the army Mr. Armstrong was associated with Babcock & Wilcox.

T. A. Noble has been re-elected president of the Engineers' Club of Yakima, Wash. The other officers are: J. O. Greenway, vice-president; A. L. Strong, secretary-treasurer, and E. M. [illegible], J. E. [illegible] and [illegible] Hewett, board of directors.

Harry T. Watts, formerly city civil engineer at Vincennes, Ind., has been appointed superintendent of the Vincennes Water Supply Co. to succeed Lawrence J. Weisenberger. Mr. Watts has been employed by the government engineering department at Camp Knox.

Col. William B. Ladue of the 207th Corps, U. S. Engineers, has been appointed United States district engineer for the Delaware River and Bay, with headquarters in the Witherspoon building at Philadelphia. He will succeed L. O. Shuman, who has been temporarily in charge of the office.

Carl E. Anderson has been elected president of the Engineering Society of Birmingham, Ala. The other officers are: Chas. Van Amburgh, first vice-president; Bert E. Nelson, second vice-president; Daniel M. Elgerton, secretary; Frank J. Tillman, treasurer; Clarence E. Beach, librarian.

John F. Nealis, who recently received his discharge from the Aero Observers' branch of the service, is now associated with the Powdered Coal Engineering & Equipment Co. of Chicago as advisory engineer. Mr. Nealis formerly had charge of research work for the U. S. Steel Corporation.

F. C. Bamman, formerly chief of the Garbage Utilization Division of the United States Food Administration, has established offices in the Woodward building, Washington, D. C., as a consulting engineer, specializing in the collection and disposal of garbage and other city waste and in the recovery of by-products from industrial wastes.

W. A. Leland has become associated with the Charleston Engineering & Contracting Co., Charleston, S. C., as chief engineer and general manager. The company specializes in reports, designs and estimates and supervision of erection or construction of hydro-electric plants, industrial plants, terminals, water works and general construction.

D. A. Burkhalter, Mayor of McKenzie, Tenn., has been elected president of the Tennessee Municipal Improvement League. The other officers are: Vice-presidents, William Gupton, Nashville; Clem J. Jones, Athens; Lawrence Taylor, Jackson, and W. E. Beach, Clarksville; secretary, Charles C. Gilbert, Nashville; treasurer, John W. Harton, Tullahoma.

L. M. Winsor, irrigation engineer for the U. S. Department of Agriculture, who has been co-operating with the Utah Agricultural College and Experiment Station, has left on a three months' leave of absence for Chile, where he will be chief engineer on an extensive irrigation project of the Guggenheims, mining engineers and promoters of New York City.

John H. Gregory, consulting engineer, New York City, has been elected to the faculty of the Civil Engineering Department of Johns Hopkins University. He will take the chair in sanitary engineering which was left vacant by the death in war service of Capt. [illegible] R. [illegible] of the Sanitary Corps, United States Army, who was on leave of absence from Johns Hopkins University [illegible].

Prof. A. A. Wood of the University of Texas has been appointed secretary of the Bureau of Municipal Reference and Research of the University of Kansas to fill the vacancy left by the resignation of Prof. Homer Talbot, who has accepted the position of secretary of the New Jersey State League of Municipalities. Prof. Wood held a like position in the University of Texas. He will also be secretary of the League of Kansas Municipalities.

Obituaries

Walter Hass, a contractor of Davenport, Ia., died Jan. 29, aged [illegible].

George B. Bushton, a contractor of Wheeling, W. Va., died Jan. 28, aged 57.

F. D. Horton, a contractor, formerly of Houston, Tex., died Jan. 25 at his home in St. Louis, Mo., aged 62.

William H. Ellis, president of the William H. Ellis & Sons' Wharf & Bridge Building Co., Boston, Mass., died Feb. 3, aged 60.

Michael O'Brien, a pioneer railroad contractor of the middle west, died Jan. 27 at St. Louis, Mo., aged 99. During the construction of the Missouri Pacific R. R. Mr. O'Brien was one of the leading sub-contractors in charge of the work.

William Benthall, for more than forty years connected with the water department of Baltimore, Md., died Jan. 27. He was superintendent of the county division until about two years ago, when he became resident engineer at Lake Guilford, which position he held at the time of his death. Among the improvements which Mr. Benthall superintended were the completion of the work on the Clifton reservoir and the entire construction of the Guilford lake. During the war he was junior engineer at the Aberdeen Proving Grounds.

Industrial Notes

Beckwith Machinery Co., Pittsburgh, Pa., has opened an office and warehouse at 1227 W. Ninth street, Cleveland, O., where it will handle the same lines of equipment as in Pittsburgh, such as Mead-Morrison hoisting engines, T. L. Smith mixers, Nagle engines and boilers, McKiernan-Terry pile hammers, Dobbie derricks, etc. The Cleveland branch will be in charge of E. G. Stoner, assisted by C. Z. Dally.

Veteran Firm Adopts New Name: Flower-Stephens Mfg. Co. Now Flower Valve Mfg. Co.

The corporate name of the Flower-Stephens Manufacturing Co., of Detroit, has been changed to the Flower Valve Manufacturing Co. The goods manufactured by this firm under the trade name "Michigan" have been well and favorably known for nearly 70 years. The original firm of James Flower & Bro. was formed in 1852 to manufacture valves and hydrants, as well as a line of ship equipment. The latter line was eventually dropped and all their energies devoted to making hydraulic supplies. Under the leadership of John W. Flower, president of the company and a son of the founder, the business has grown rapidly. When this country entered the war the plant was placed at the disposal of the government, and because of their long experience in ship fitting they were asked to build materials for the ships built under the direction of the Shipping Board, as well as to supply their regular product for camps and cantonments here and abroad. Propellers, throttle valves, bilge piping, ballast piping and valves, strut bearings and stern bearings were turned out, sufficient to equip 25 ships per month. This work was so well done that official recognition came to them in the form of special commendation for both the high standard maintained and the quantity produced.

John W. Flower, President Flower Valve Manufacturing Co.

Railways and Excavation Monthly Issue

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[illegible] RICHARD E. [illegible], *[illegible] Manager*

[illegible], *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The *articles* in the first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering and contracting field. The *articles* in the first and last issues of each month (1st and 4th Wednesdays) completely cover county engineering and highway engineering and contracting. The *articles* in the third and last issues of each month (3rd and 4th Wednesdays) completely cover steam and electric railway location, design and construction. See the "mast head" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellany

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power

Railways and Excavation—3rd Wednesday
(a) Excavation, Blasting, Dredging
(b) Rock and Gravel
(c) Quarries and Pits
(d) Railways—Steam and Electric

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbors Structures
(d) Miscellaneous Structures

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The Daily Press Must Support the Public Service Commissions Or Municipal Ownership Will Soon Come

We have noted during the past few months, many editorial criticisms of state public service commissions. These criticisms have come mainly from the daily papers in states where the commissions have raised the rates charged by certain public utilities. The papers of California are notable offenders in this matter. We call them "offenders," for they assuredly know that the California commission is above reproach as to its integrity.

A public service commission never takes any pleasure in raising rates, for it knows very well that it will not please the public by so doing. Yet the commissioners must rely upon public approval if they are to continue long in office. Hence the evidence that convinces a commission that rates should be raised must be very conclusive evidence, yes, overwhelming evidence. In many states public service commissions are so timid for fear of displeasing the public that they rarely raise any rates. When a commission is courageous enough to do its duty, must it immediately become the target of editorial criticism? Shame upon the editors who thus curry popular favor!

In Chicago at this time there is a good deal of talk of either abolishing the state public service commission entirely or of depriving it of the power to regulate utility rates in Chicago. And why? Simply because it is believed that no local commission or city council would ever dare raise the rates. Isn't this a fine display of honor! If a defendant in a civil case were to refuse to be tried unless it were before a jury composed of members of his own family, we should have the exact counterpart to a body of street car riders insisting that a few of their number should determine whether or not the nickle fare should be raised.

As a matter of fact, it would be well were state public service commissioners appointed for life. Like Federal judges they should be entirely free from local prejudice or partisanship, and free from all fear of public revenge when their decisions are counter to popular wish. One of the weaknesses of a democratic Government springs from the belief that the majority should always control. The minority has certain rights that the majority should respect. The courts constitute an instrument for securing protection of those rights. A public service commission is essentially a court, and one of its functions is the protection of the property rights of owners of public utilities. At least that is the theory, and it is a sound theory. But in practice our state public service commissioners are frequently intimidated by the public. So frequently has this been the case that many street railway companies are now at the very doors of the bankruptcy courts. Wages and prices have risen fully 50 per cent, but the same old nickle fare is all that most street car companies are permitted to collect.

It is true that in some 350 American cities fares on street railways have been raised. It is true that more than half the urban population of the United States is paying increased fares.* But there are still hundreds of street railway companies that have had no aid, and are financially starving to death. Why? Mainly because local politicians and state public utility commissions have not yet dared to grant them higher rates. And this in justice loving America!

Isn't it time for the public press of this country not merely to cease its criticism of rate-making commissions, but support them when they do their duty? If not, then [illegible] all street railways and [illegible] extent. The [illegible] support of [illegible] municipal ownership [illegible] of this issue.

San Francisco's Municipal Railway Is No Gold Mine

[illegible] American city that owns and [illegible] of street railways. It [illegible] demonstrating [illegible] the latest complete statistical report will prove a sad disappointment to those who have been urging that San Francisco should buy out the privately owned street car lines.

For the year ending June 30, 1917, after deducting bond interest, depreciation and "lost taxes," this municipal railway [illegible] shows a deficit of nearly $104,[illegible] [illegible]

[illegible]	
[illegible]	$[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	$1,[illegible]
[illegible]	
[illegible]	$[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	
[illegible]	[illegible]
[illegible]	$1,[illegible]
Total operating revenue	1,477,910
[illegible]	$[illegible]
[illegible]	[illegible]
[illegible]	$[illegible]

The annunity for depreciation is 14 per cent of the total operating revenue, and the annuity for injuries and accidents is 4 per cent of the same total. The railway pays no taxes, but its charter requires an estimate of what would be paid were it privately operated.

The interest on the bonds ($238,069) indicates that the system must have cost more than $100,000 per mile of track. The electric power is purchased. There are 198 cars owned, and there were 5,317,269 car miles for 1917, the operating expense of which was 18.17 ct. per car mile. The conductors and motormen received 37.5 ct. per hour for an 8-hour day. Passenger-car hours totaled 580,716.

For the year 1916 there was a profit of $74,768 instead of the deficit of $103,908. The total passengers carried in 1916 were 47,886,764, as compared with 36,234,723 in 1917. The fare is 5 ct.

These data serve to indicate that a street railway system is no such "gold mine" as the proponents of municipal ownership would have the public believe.

A Three-Year Old Definition of Engineering

For more than a dozen years a few engineers have been preaching the doctrine that engineering is the systematic application of science—any science. Now that the majority of engineers have been won over to this broad conception of engineering, it will not be long before it will be said that this has always been the implied, if not the avowed, conception. Therefore it is interesting to quote definitions of engineering that indicate the narrow conception that was prevalent a few years ago. In a recent issue we quoted some definitions from dictionaries and encyclopedias. In a book published in 1916, entitled, "Engineering As a Career," the first chapter is by Albert J. Himes, M. Am. Soc. C. E., past president of the Cleveland Engineering Society. Mr. Himes says (page 2):

"An engineer is a man who, having a liberal knowledge of scientific truth and due respect for Nature's laws, can both plan and carry out with safety and success the great works which are necessary for the convenience and welfare of mankind. Engineering is the practical application of mathematical and physical science to the needs of man."

It is to this last sentence that we wish particuarly to call attention. Note the specific limitation put upon engineering. If the word "physical" is given even its broadest meaning, several sciences fall outside its limits. The science of psychology, for example, is excluded. Yet the science of management, which most of us now regard as a branch of engineering, rests largely upon the practical application of certain principles of psychology.

Going on, Mr. Himes says:

"The engineer makes the plan, determines the size and dimensions of the structure, provides for its safe and successful operation and estimates its cost and earning capacity. Before the first move to create the structure, it has been completely formed in the brain of the engineer. His language is one of blue prints. He does not talk in words."

It is difficult to reconcile the last two sentences with a later statement by Mr. Himes (page 8): "An engineer should be a leader of men." True, but to be a successful leader an engineer must "talk in words," and he should be a student of the science of mental kinetics, psychology.

Doubtless Mr. Himes would disclaim any intention to exclude any science from the province of engineering, provided it could receive economic application. What we wish to indicate is that the old tradition that engineering is purely mathematical and physical in its cope, still prevents many a good engineer and many a teacher of engineering from giving voice to the idea that "economics" and "scientific management" should be studied continuously by all engineers.

Will Motor Trucks Stop the Building of Short Branch Line Railways?

There is a growing belief that, with the building of good roads, fewer branch line railways will be needed. The argument is that motor trucks can economically carry produce long distances over hard roads, and that they can go direct to the door of the producer.

Recently the editors of electric railway magazines have been combatting the theory that motor trucks will eventually secure nearly all the short-haul freight and express. They point out, for example, that a two-car electric train, manned by three men, can haul 60 tons of freight 100 miles in a working day. The editor of the Electric Railway Journal says:

"Electric cars will require only one-tenth the labor and one-third of the equivalent fuel, and besides there are other little matters such as life of equipment and general maintenance very much in our favor. The ability of the truck freighter to collect his load at the shipper's door and deliver it direct to the consignee is offset by the greater mileage which electric cars can make when handling local freight and the greater security offered the owner of the freight, not to count such other things as highway wear and tear which the trucker leaves to the public purse through taxes of which he ordinarily pays a minimum."

There is no doubt that the present tendency, even among civil engineers, is to overlook the great economic possibilities of freight haulage over electric railways. There is also too little thought given to the possible uses of gasoline motor locomotives on branch line railways. The tendency is to regard all railways as necessarily very costly to build and to operate. But, as a matter of fact, a single track railway paralleling a country road can be built as cheaply as a road pavement 16 ft. wide. This question therefore arises: Will not all main highways eventually be paralleled by a gasoline railway track laid within the same right of way?

It seems to us that this is probable. It also seems likely that motor trucks capable of running on rails as well as on pavements will be used very extensively. This is already being done in California, and we see no reason why this plan should not become universal. The wear and tear of rubber tires is a very large item of truck expense [illegible] can thus be largely eliminated. The tractive resistance on rails is about one-third the tractive resistance on the best of pavements. Hence higher speeds can be secured by motor trucks running on rails, and with less gasoline consumption. But even more important is the ability to pull several trailers heavily loaded.

No, the day of the short branch line railway is not coming to an end because of motor trucks. Rather is the coming of the motor truck likely to give great impetus to the building of railway lines to be used by motor trucks.

The Paramount Duty of Engineering Societies in the Present Emergency

Strange as it may seem, a policy that is economic from an individual point of view may not be economic from a public or social point of view. Thus it may be economic for an individual to defer building a house until prices fall, whereas it would be economically disastrous were public works held up generally in order to secure lower construction prices.

It is beginning to be realized by business men and public officials that this country faces a condition of serious unemployment unless federal and local governments speedily provide for extensive public works. Individuals and companies are waiting for prices and wages to recede before launching construction programs. If public officials also wait, the effect will be disastrous.

Prof. Harold G. Moulton, political economist of the University of Chicago, says:

"War contracts amounting to many billions of dollars annually must shortly be replaced by peace contracts for more than a like amount. The situation with which we are confronted is without parallel in our industrial experience. . . . If industry is to go ahead, the business man must have assurance that there is at least a reasonable probability of profits. At the present time there is, however, much uncertainty as to the strength of the demand for many lines of peace-time production, and like uncertainty as to the costs of production. As a result business is nearly everywhere hesitant. . . . .

In view of the established facts of our industrial experience and in view of the grave possibility of depression during the transitional era—indeed, I think one may say in view of the facts of the immediate situation—with industry everywhere hesitant, and unemployment already rapidly increasing, is it not perfectly plain that a comprehensive program of public works should be instituted just as soon as possible? If this nation is not willing to heed the simple lessons of experience, and if we are not disposed to seize at once the opportunity to insure ourselves against the dangers of the transition periods by establishing a perfectly feasible program of buffer employment on public works, we deserve to reap the whirlwind that will lie before us. In view of the present social temper of the world we cannot afford to sit with folded hands and await the return of the troops with nothing but fine resolutions and good wishes to extend them. If, in our easy-going optimistic American way, we neglect to provide for those who have so unreservedly offered themselves in the nation's service the opportunity upon their return to earn the means of a self-reliant existence, we will have sown the seeds of a social revolution in this country that will rock our democratic institutions to their foundations."

It is the clear duty of every engineering society in America to take an active part in solving the tremendous economic problem of "readjustment." Yet very few engineering societies are doing more than discuss the matter.

A few weeks ago some 400 public officials and business men met in Chicago to fight the Railroad Administration's proposal to increase freight rates on sand, gravel, slag and stone. Every dollar spent for freight means a dollar less available for labor on roads, streets, etc., at a time when there is crying need of money with which to employ construction labor. Not a single engineering society was represented at that important conference!

It is just this sort of apathy about economic affairs of public concern that is retarding the progress of engineers in public life, and restricting their chances to apply their really broad knowledge of economics.

Seventeen Per Cent of the Civil Engineers in the Army and Navy

The American Society of Civil Engineers has almost 9,000 members. On January 8, 1,537 of these men, or 17 per cent of the total membership, were serving in the allied armies and navies. Ninety-three per cent hold officers' commissions.

Before summer nearly all these engineers will be discharged from the army, but if every engineering society will exert itself, to secure appropriations for public works, there will be positions available for every civil engineer in America.

What Can Engineers Do to Promote Railway Construction?

Although the Division of Capital Expenditures authorized the railways to expend a billion and a quarter of dollars for new equipment, additions and improvements during 1918, less than half that sum was actually expended. Doubtless railway officials felt that the war necessitated every possible economy. Now that the war is over, however, there appears to be no pronounced activity on the part of the railways, in preparing for future business growth.

Manufacturers of railway supplies are complaining bitterly over the failure to receive orders. Scarcely any new construction work worthy of mention has been announced. The railways are waiting for Congress to decide whether the Government is to continue its present management or whether the railways are to be turned back to their owners.

The railways can not be blamed for refusing to go ahead until their future status is decided. There is much talk about the necessity of large public works appropriations, and this agitation is beginning to bring results. There is just as great need of large appropriations for new railway construction, but no organized effort is being made to persuade Congress to take action. So spring is fast approaching and no preparations are being made to begin railway work on a scale commensurate with the economic needs.

The civil engineers of America could perform no greater public service at this moment than by bringing organized effort to bear upon Congress. Civil engineers constitute the class of men that are best able to advise Congress as to what should be done in railway construction. Engineers came to the rescue of the Government when the war began, and 8,000 engineers became officers in engineer regiments. These same men are available, or soon will be, for public service. They and their fellow engineers should lose no time in taking steps to persuade Congress to decide upon a railway policy.

Restriction of Title "Engineer"

To the Editor: I note the communication in your last issue from Robert W. Shelmire, upon the definition of engineer. Did I not know Mr. Shelmire personally this communication would convey the impression that he belonged to the class who would lose some of their pretension in the event that the use of the title "Engineer" should be restricted to such as are justly entitled to use it.

The legal profession is hedged by precedent and uniformly faces backwards, seeking guidance from antiquity. The engineering profession has no excuse for existence unless it be constructive. It must face forward and bend the forces of the future to the betterment of mankind.

The medical profession were faced by an abuse of the title of "Doctor." There were corn doctors, voodoo doctors and plain humbugs. Undaunted by the fact that the

[illegible]

Why should not the engineers face the future, adopt titles [illegible] and prescribe a minimum requirement for one to [illegible] title. This should be a requirement which will bar [illegible] study and perform labor necessary to qualify him. Colleges are aiding by no longer granting the title to graduates from study until they have gained practical experience.

[illegible] standards they may fairly ask the public to support a just compensation. The public justifies the medical profession [illegible].

[illegible] will be more respected as a good draftsman than as doubtful engineer. [illegible] to the profession instead of lowering the profession to fit the man.

A. M. VAN AUKEN

[illegible]

Civil Engineer Appointed Secretary of City Board of Commerce

[illegible] E. & C. frequently [illegible] editorials regarding the engineering profession and why it should seek public offices, managerships, and other positions. I am attaching a clipping that may be of interest to you. After reading it you will note that under Mr. Wiles' qualifications the committee of the Board of Commerce state:

"First. He is a practical, experienced civil engineer."

This occurs to me as noteworthy as it indicates that the pendulum is swinging in the right direction.

THEO. A. POLANSKY

Parkersburg, W. Va.

The clipping mentioned by Mr. Polansky refers to the appointment of Mr. J. B. Wiles, formerly secretary of the Chamber of Commerce of Philipsburg, Pa., and Business Manager of that city, as secretary of the Board of Commerce of Parkersburg. The committee gave the following reasons for the selection:

First—He is a practical, experienced Civil Engineer.

Second—He has had [illegible] years of training with the Pennsylvania R. R. in the mechanical and industrial departments.

Third—In the past 5 years he has devoted his efforts almost exclusively to the study of civics and industrial operations.

[illegible] He is now working under the Bureau plan at Phillipsburg, and has a well organized Credit Rating Department as a part of the Chamber of Commerce equipment. He is Business Manager of the War Resources and Conversion Committee, Section No. 5, of the Pittsburgh Zone of the War industries Board, and is local Fuel Administrator. He is eminently qualified to take up the work in Parkersburg with a thorough practical knowledge of every detail of the Board's activities.

[illegible] As Business Manager of the City of Phillipsburg he would come to us with a thorough, practical knowledge of those things that are necessary for the practical advancement of civic building and community development, and his experience in an industrial center would be most valuable in drawing to Parkersburg [illegible].

Thaw Frozen Ropes Before Using.—Frozen ropes should be thawed before being placed in service. When frozen [illegible] brittle and are likely to break because some of the fibers get more than their share of the load.

The Pay of Railway Technical Engineers

A [illegible] schedule of monthly salaries for railway technical engineers, recommended to the U. S. Railroad Administration by the American Association of Engineers, is reproduced below. This schedule was prepared by the association and approved by its Railroad Committee, consisting of Mr. W. H. [illegible], Mr. E. H. Lee and Mr. W. W. K. Sparrow. It is the first attempt by an organization of Engineers to say what salaries should be paid. While the schedule [illegible] in the railroad field it does lay the groundwork for uniformity in classifying the various positions in railroad engineering departments. The schedule follows:

	Railroads having over 5,000 miles of track	Railroads having less than 5,000 miles of track
Chief Engineer. [illegible] responsible for all engineering work and organization, including valuation	Salaries commensurate with duties performed.	
Assistant Chief Engineer. In charge of [illegible] territory, reporting to Chief Engineer; responsible for such work as may be assigned to him by the Chief Engineer	Salaries commensurate with duties performed.	
District Engineer. In charge of two or more divisions reporting to Assistant Chief Engineer in charge of that territory, responsible for all maintenance of way and [illegible] construction	$425	[illegible]
Assistant District Engineer. Same territory as District Engineer, like responsibilities. Reporting to District Engineer	[illegible]	[illegible]
Division Engineer. In charge of one division, responsible for all maintenance of way and permanent way work	[illegible]	[illegible]
Resident Engineer. In charge of one residency, reporting to Division Engineer. In charge of construction work only. This position not required for maintenance of way or permanent way work	[illegible]	[illegible]
Assistant Engineer. Acts as assistant to Division Engineer, Assistant District Engineer, and Assistant Chief Engineer. Responsible for such duties as may be assigned him	275	[illegible]
Chief Draftsman. Reports to Chief Engineer or Assistant Chief Engineer; in charge of general drafting room at principal headquarters	Salaries commensurate with duties performed.	
Engineer of Bridges. Reports to Assistant Chief Engineer or Chief Engineer. Responsible for maintenance and construction of all bridges—wooden, steel, and concrete	400	350
Valuation Engineer. Responsible for all valuation work on entire system. Reports to Assistant Chief Engineer or Chief Engineer	400	350
Assistant Valuation Engineer. Reports to Valuation Engineer; has like responsibilities	350	275
Superintendent of Motive Power. Responsible for maintenance of all mechanical equipment	Salaries commensurate with duties performed.	
Assistant General Superintendent of Motive Power. Responsible for maintenance of all mechanical equipment on entire system or portion of system, as may be assigned by General Superintendent	Salaries commensurate with duties performed.	
Mechanical Engineer. Responsible for such work as may be assigned to him by General Superintendent or Assistant General Superintendent. Reports to Assistant General Superintendent or General Superintendent	400	325
Electrical Engineer. In charge of all electrical construction and repair work of mechanical equipment. Reports to Assistant General Superintendent or General Superintendent of Motive Power	325	275
Assistant Electrical Engineer. Like responsibilities to Electrical Engineer. Reports to Electrical Engineer and Assistant General Superintendent or General Superintendent	275	250

	Salaries [illegible] year or more	[illegible] work, less [illegible] year
Signal Engineer. [illegible] General M[illegible] [illegible]	[illegible]	
Assistant Signal Engineer. [illegible] or General Manager. In charge of [illegible] Signal Engineer.	[illegible]	
Instrumentman. [illegible]	[illegible]	[illegible]
Rodman. [illegible]	[illegible]	[illegible]
Tapeman. [illegible]	[illegible]	[illegible]
Designer. Reporting to Chief [illegible] assigned, and qualified to prepare [illegible] design [illegible] architectural work.		
Draftsman. Reporting to Chief [illegible]	[illegible]	[illegible]
Junior Draftsman. Reporting as [illegible]	[illegible]	[illegible]
Tracer. Reporting as assigned, and qualified [illegible]	[illegible]	[illegible]

In this connection it is interesting to note [illegible] engineers of several large railways, having [illegible] in Chicago, have recommended new schedules for their engineers. These schedules, according to The Monad, are as follows:

	Road A.	Road B.		Road C.
		Minimum.	Maximum.	
	Per month.	Per month.	Per month.	Per month.
Division engineer..	$335.00	[illegible]	$400.00	$320.00
Assistant engineer.	[illegible]	250.00	300.00	225.00
Instrumentman ...	175.00	175.00	200.00	190.00
Rodman	145.00	75.00	90.00	125.00
Tapeman	120.00	[illegible]	[illegible]	90.00
Draftsman	*200.00	130.00	175.00	†200.00
Chief draftsman......	250.00	[illegible]	250.00	[illegible]

*$150 to. †$130.00 to.

The Monad also states that one railroad put into effect, Dec. 1, the following rates of pay:

Draftsman	[illegible]
Chief draftsman	225.00
Division engineer	200.00
Assistant engineer	150.00 up
Instrumentman	[illegible]
Rodman	90.00
Inspectors, [illegible]	[illegible]
Inspector, [illegible]	[illegible]

These men are all on the staff. The division engineer does not have maintenance in charge, but the roadmaster takes this function. Roadmasters are paid $200 a month and some are engineers. All positions carry expenses away from headquarters.

The district engineer is a staff officer and has 1,500 or more miles of track to look after, comprising generally four divisions. He receives at the present time $300 a month. Recommendations of new schedule have been made but not yet approved.

There is no overtime paid except in unusual cases, such as several nights' work or Sundays. The arrangement to care for overtime is reciprocal. A men who works overtime is allowed at least the same amount of time away from the work during regular working hours.

World's Champion Single Jack Driller.—The recent death of Fred F. Yockey at Camp Seco, Cal., brings to mind the old-time hand drilling matches that were always features of the Fourth of July and Labor Day celebrations in mining camps of the West. Yockey was the champion single jack driller, winning the title in 1904 in a match at El Paso, Tex. In this contest he made a record of over 24 in. in Gunnison granite in 15 minutes' drilling. This record has never been surpassed. With the passing of interest in drilling matches Yockey dropped from public sight, but old-time mining men from Colorado, Arizona, Mexico, Montana, Nevada and other Western states still talk about his great prowess with the drill and hammer. He was a small man, weighing about 150 lb., but his ability to drive a drill into the hard rock was astonishing.

Time Studies in Hand Shoveling Bring Increased Output

[illegible] of nearly a year were conducted in 1918. The results of these studies are given by Mr. G. Townsend Harley, Efficiency Engineer, Phelps-Dodge Corp., in a paper presented at the February meeting of the American Institute of Mining Engineers.

The tests showed that the design of the shovel has a very marked effect on the shoveling efficiency and that with the proper weight and size of tool the man's efficiency will be increased in spite of himself. It was demonstrated that a man handling a total load of 26 lb. 8 oz. did the greatest day's work, other things being equal, and that this load is divided into a live load of 21 lb. and a shovel weight of 5 lb. 8 oz. A shovel weighing 5 lb. 8 oz. made out of the best composition steel gives a very excellent service, and a lower cost per ton than a shovel having a lower first cost.

Further marked increases in shoveling efficiency are to be gained by instructing the shovelers in the proper methods of using a shovel, a thing that very few laborers know in spite of the fact that they may have been shoveling for a living for years.

Probably the most important part of all efficiency work lies in the wage that is paid to the men, the manner of paying the wage, and the feeling of confidence and good will that exist between the men and the company. The conclusion is reached that the bonus system in some form, if properly handled and carefully watched with a sufficient number of specially trained men to instruct the laborers and keep them working to the best advantage, is the preferable system of payment. A bonus schedule is proposed as a starting point for the work and the benefits that will probably be derived from it are outlined, using some actual stoping experience as an example.

Scientific management systems applied to certain eastern factories have demonstrated conclusively that the efficiency of the average workman can be increased by from 50 to 250 per cent and that at the same time the men will receive better wages, will remain in better health, and will be happy and contented, while the company will actually produce its products at a lower cost.

F. W. Taylor, working at the Bethlehem Steel Co. plant several years ago, increased the capacity of the iron-ore shovelers from 16 ton to 59 ton per day per man, raised the men's wages from $1.15 to $1.88 a day, and at the same time decreased the operating cost from $0.072 to $0.033 per ton shoveled. The increase in shoveling capacity amounted to 269 per cent. Figures obtained at Tyrone indicate that the tonnage in at least one of the large stopes can be raised from 8.5 ton per man to 22.9 ton per man, an increase of 169 per cent, the wages can be raised from $3.40 a day to $4 a day, and the cost to the company reduced from $0.33 a ton to $0.24 a ton, after taking care of all extra supervision needed. In addition to this actual saving in shoveling costs, the overhead and general mining costs will be reduced per ton by mining a greater tonnage per man; and the other classes of labor such as machine miners and timber men will be able to do more work, as they will not be hampered and delayed by the shovelers to such an extent as at present.

Labor should not be given too much of an increase in wages over what is recognied as a fair living wage, as the men will at once tend to become shiftless and prosperity does them more harm than good.

The modern manager is beginning to see that the relation of standard times to the other features of organization is very close and vital. The determination of the standard, or the shortest time, in which a job can be done, is the starting point for all work that has as its aim the establishment of an equitable wage system.

What Shall the Government Do With the Railroads?*

[illegible] shall the Government [illegible] the railroads? Government ownership or [illegible] a return of the [illegible]?

Government Ownership [illegible] have no competitive [illegible] and the danger to our [illegible] of the [illegible] from Govern[illegible] consideration.

From an engineer's standpoint, this country is young, [illegible] resources have hardly been scratched, and [illegible] Government ownership would be extrava[illegible] on any basis, but primarily because it destroys the reward for initiative and [illegible] necessary for the [illegible] of the country and our national prosperity.

[illegible] Government ownership throttles competition, which is a necessary incentive for proper service to the people in every part of the country and every city in the land.

[illegible] Five Years.—Some of the things which were [illegible] during the war which should be undone at once and not 5 years hence, are:

[illegible] of the various railroads, which were dispersed, should in great part be re-assembled and re-habilitated at once. Such departments are as necessary in dealing with the public for the sale of transportation [illegible] selling departments of any other business, and can be of great service to the public in many capacities.

[illegible] as a national effort of an attempt at standardization of all manner of railroad necessities [illegible]. Such standardization, while it has a certain [illegible] economy when applied to quantity productions in the scheme of things in this country, tends to inefficiency, and should be a local question only in a limited locality. Our tools and methods are so crude that the national efforts should be to improve, not to standardize.

The horizontal raise in railroad wages of the entire country in one order which was necessary during the war is a pernicious destroyer of individual discipline, and debauches and atrophies the ambition of the men receiving such increase and should be abolished in time of peace for re[illegible] between employers and their own employes as soon as possible.

The [illegible] of the public, some of which was necessary during the war, should give way to even better facilities than offered before the war, the direct tax of an increase of passenger rates should be reduced to a minimum, even if an indirect tax of increased freight rates is necessary to pay the bills. The movement of the people freely around and about our country should be encouraged as in[illegible] and social well being, and tending to a unity of spirit which is good for the body politic.

The discontinuance of regional consolidation, which was necessary for operation during the war, and an immediate return to a competitive basis in all matters pertaining to service to the public.

The terminal problem, which was made so acute by lack of ships and storage facilities, is largely one of changing our commercial methods, pooling facilities, and providing for the prompt unloading of cars. Belt railroads are needed and should be built in many places, but the matter is a local one peculiar to each community, and best handled as a financial policy of such community and not by the Federal Government.

We have great national efforts to make in world affairs, and the sooner we put the vim of an owner's interest back of the largest business interest in the country the better.

Return to Private Ownership as Soon as Enabling Legislation Can Be Passed.—This country is so young and undeveloped that the railroads should exist and be encouraged primarily for the development of our material welfare, and, for the good of all, the railroads should be returned to their owners as soon as possible so that their growth will naturally follow the normal business needs of the country tested by business standards and not directed into any predetermined course which would be determined by a centralized Governmental agency.

Returning the roads to their owners under old conditions would mean financial chaos in the country, and some legislation with certain Governmental controls is absolutely necessary.

The normal growth of our country requires that the railroads spend in the next 5 years at least four billion dollars for improvements, betterments, and normal growth of our transportation service, and a continuing and enlarging amount thereafter to meet our growing needs. While the Government finds it necessary to put out varying issues of Liberty Bonds, it seems best that they buy the securities of the railroad as needed until the public regains confidence enough to take the investment out of their hands. This will require a possible advance of from a billion and a half to two and a half billion dollars, for which the railroads could be charged a high enough annual interest charge, over and above the cost of the money to the Government itself, to pay off the debt within 20 or 25 years.

It will take a stable continuing railroad financial policy to renew the confidence of the public in railroad securities, and it seems to me that the railroad interests of the country, which is the largest single interest, should write off all extraordinary war costs within a short generation and lesser business interests in less time—in fact, I think, to keep step with the age, the Government should find financial measures to write off and obliterate all its national war costs within 30 to 40 years or less.

The principle of a fixed financial policy and the control by the Government necessary to carry out such policy under all ordinary business cycles should be made a law by Congress. The control should be of an enabling nature and not more restrictive than is necessary, and might at the present time well consist of:

First.—A control of rates initiated by the carrier. The rate question is largely an artificial issue and little understood by the public. The shippers of the country are chiefly interested in rate relationships and the ultimate consumer in the amount of the rate as he really pays the bill. We hear of the shippers through their lawyers, but the ultimate consumer is rarely heard, because his indirect tax due to the rate alone is so very small. There are posibilities in a more logical rate structure for settlement of most of the misunderstanding between the public and the shipper, and between the shippers themselves, for which the railroads usually hold the bag. In connection with the control of rates, the Government should have an unbiased economic study made for a more logical application of rates than at present.

Second.—The wage question of the railroad employe, like other inflations of the war, will be settled sensibly by public opinion. It does not seem a proper Governmental function to settle wage scales, and it is for the best continuing interest of labor itself that such questions should be returned as soon as practicable to be settled between employers and employes. It is necessary, however, that the Government take cognizance of such matters in the control of rates.

Third.—A control of unproductive expenditures required by the public, and particularly as to the grade crossing elimination question which threatens to be of serious financial importance in the near future so that due cognizance may be taken of such expenditures.

Fourth.—A control of issue of securities for improvements and consolidations and of the necessary railroad accounts. Generally, the weak lines should be consolidated with the strong, and the large lines prevented from becoming so large that they eliminate competition from any section of the country.

Fifth.—A control in safety matters.

Sixth.—A recognition that for the continuing solvency of the properties the voice of the general public, whose welfare is at stake, and the voice of the owners of the properties, should be heard with that of the shippers and representatives of the employes.

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*[illegible] by Francis Lee Stuart, formerly Chief [illegible] R. R., presented Feb. [illegible] before the New York [illegible] Society of Civil Engineers.

In my opinion, the proper principles for legislation for a fixed financial policy should be based on an average railroad efficiently operated, receiving, as a minimum, a fair profit for the transportation it has to sell, and that fair profit must include:

1.—An adequate going return on the investment over the cost of proper service to the public.

2.—A return for such money as is borrowed for improvements required by the growth of the country, which will include the cost of the money plus an added equity to the corporation in compensation for extending their credit and brains as collateral for such money.

3.—The further right to build up such surplus as this class of business, wisely conducted, should have in reserve for emergency.

Nothing short of such a financial policy under private ownership will bring investors back to the support of the railroads and keep up the healthy growth of our country. Nothing short of such a financial policy, under private ownership, will give the people of our country a healthy sense of freedom and the right to demand competitive service for their happiness, comfort, and material benefit.

The matter of return of the railroads to private ownerships on a basis of such a financial policy can be applied at once without an absolute determination of results before the policy is adopted. For a willing trader, the securities and proper earnings on the investments of the average railroad with the many years of a repressive public policy putting increments of values into the properties, should not be difficult to determine within safe limits. On any given rate, some roads will fall and others will prosper, from many different causes, but the extremes can be regulated to meet the political feeling of the times by the beneficent use of an excess profit tax.

With the principles of a policy fixed, and controls whereby it may be made effective, the means for carrying out the purpose could be more flexible and could consist of a number of commissions with some co-ordinating force, all safeguarded in certain cases by right of appeal to proper courts.

The entire matter is of such importance to the whole country that, if this session of Congress cannot settle the question, then an extra session should at once be called for this purpose. It seems to me, it is the simplest of our readjustment problems, and the one needing the most immediate attention, and the one most important for the immediate welfare of the country.

Suggested Wider Use of Zinc Treated Ties.—An apparent relation between the amount of rainfall and the durability of railway crossties treated with zinc chloride disclosed by a recent Forest Products Laboratory investigation was discussed at the January meeting of the American Wood Preservers' Association in St. Louis. The report of the investigation is based on an analysis of service records and suggests that a zinc chloride treatment should give an average life of 8 years or more to ties made from non-durable wood in that portion of the country north and west of the 40-in. rainfall line. This line extends, roughly, from Galveston through St. Louis and Pittsburgh to Northeastern Maine. Allowance would have to be made according to the report for that portion of the Pacific Coast where there is heavy rainfall. Creosote for treating crossties has been hard to obtain for the past two years due to restricted importations and increasing use of coal tar for fuel by the steel industry.

Regulation of Water and Rail Rates.—I believe that the Interstate Commerce Commission should have the same jurisdiction over the regulation of water rates as it has in the regulation of rail rates. Both water and rail transportation must work together in order to bring about the best results. Canals and railroads should not be competitors. They should have through rates on an equitable basis and each support the other.—H. S. Noble, Federal manager of the Newark and New Jersey Canal Section, Division of Inland Waterways, in address before the National Rivers and Harbors Congress.

Safety Fuse: Selection, Storage and Use

[illegible] suggestions on the use of safety fuse are given in Bulletin No. 9 of the Industrial Accident Commission of the State of California. The following notes are abstracted from the bulletin:

Conditions Governing Selection of Fuse.—It is important that attention be directed to some underground conditions that should be taken into consideration, particularly by inspectors when making recommendations regarding types of fuse best suited for the work. Where water drills are in use, the employment of a tape-covered fuse is recommended, the grade depending on the temperature and the amount of water and the nature of the ground.

When acid is present in sufficient quantities to make it necessary to line the mine pumps with bronze, the use of a fuse of the triple-tape type is desirable. It has been clearly demonstrated that the lighter forms of jacketing do not meet this severe condition satisfactorily.

In a poorly ventilated mine, the use of a white cotton-countered fuse should be discouraged, for the reason that this type of fuse is more easily penetrated by the moisture precipitated by slow-moving air currents than is the black-finished type.

Storage of Safety Fuse.—Fuse in transit may be easily spoiled by being allowed to come in contact with moisture, or with oily or greasy substances, or by being exposed to the direct rays of the sun for any considerable time.

Inspectors should caution superintendents or foremen that fuse which has had oil, gasoline, or distillate spilled on it, or that has been carted to the mine during wet weather without being protected, is likely to be the cause of misfires.

Proper storage of safety fuse is a vital factor. On every case is found the caution, "Keep contents cool and dry." It is absolutely imperative that this be followed to the letter. Fuse which has been stored underground is never in prime condition.

It should not be stored near a boiler, furnace, hot steam pipe, or lighted stove. Exposure to heat for only short periods may result in misfires, or may retard the rate of burning, and so greatly increase the liability to cause holdbacks. Fuse that becomes overheated to such a degree that it is absolutely spoiled is harmless, but fuse that has been overheated only to such a point that the powder train has become partly saturated with the materials that were originally put on as a water-resisting covering is extremely likely to cause serious trouble, owing to irregular burning.

Fuse stored in temperatures ranging from 45° to 75° F., in buildings that are dry, will remain in good condition for a considerable time. It is, however, always well to restrict this storage period to a matter of months. Sometimes lack of surface buildings forces temporary storage of fuse, in its original cases, underground. The underground storage place should be well ventilated and cool. A drift or tunnel in which conditions are such that hay or grain will become mouldy is absolutely unfitted for storage of any explosive.

Storage of fuse in a damp place retards its burning speed. Even if precautions are taken to attempt to re-dry the fuse before using, it will be found that the burning rate has slowed down and is irregular. This irregularity tends to increase the liability of misfires.

It should be remembered that fuse waterproofing is quite as effective in keeping dampness in as it is in keeping external water out, and for this reason the thorough drying of fuse that has once been wet is indeed difficult. Experiments have proved that the burning speed of fuse that has been stored in a damp place varies from 17 to [illegible] per cent from normal. Exposures to comparatively high or low temperatures for long periods of time retard the burning speed. Cotton-covered types of fuse do not exhibit the marked changes that the tape-covered types do. Fuse warmed near a stove showed variation in burning time up to 28 per cent.

When considering the matter of uneven burning time of fuse, it should be remembered that poor storage and the placing of the fuse under uneven tamping and powder loads, in the same round of holes, are responsible for most of the complaints.

[illegible]

[illegible] function, placing a foreign substance between the ends of [illegible] oil, grease [illegible] distillate, or a paint containing turpentine or lin- [illegible] water from the fuse.

Certain causes of misfires have been overlooked by the [illegible] complaints. Such causes include the following:

1. Fuse powder has been knocked from the end of the fuse by the use of a wire brush, in a misguided attempt to clean the end of the fuse before it was inserted in the cap.

2. Axle grease had been smeared on the entire 50-ft. length of the fuse before it was cut into the desired lengths [illegible]

3. A mixture of black powder and guncotton that had been allowed to become wet was placed in the caps before [illegible]

4. Fuse had been placed in a warm room for several days before it was used, after being capped and dipped, in some cases in light grease and in others in cable dressing.

5. Fuse had been capped and hung submerged in a barrel of oil several hours before using.

6. Fuse had been allowed to hang on nails, underground, for days and even weeks before use.

7. Fuse was cut, capped, and then piled on the floor of the drift for weeks before an attempt was made to use it.

8. Large quantities of fuse were hung on nails, for long periods of time, before use. This caused a fracture of the powder train.

9. Primers were placed over the crossbar of the cage, and jerked down sharply to hold them on the bar while being lowered into the mine. The jerking was sufficient to fracture the powder train of the fuse.

10. Defective caps. These caps had been spoiled by exposure to steam and moisture.

Another cause of misfire, not so generally recognized as it should be, is the sweep of the air returning to place during blasting operations. This feature is most noticeable in development work, and particularly in massive ground. The displaced air returning to place causes several things to happen. The most common is the throwing of powder out of untamped holes; another, in wet holes, is the driving of the water with great force into the powder cartridges. This at times will so completely surround the powder with water as to cause an imperfect shot. Still another is the destruction of the fuse in the hole that is wet through saturation.

Causes of Uneven Burning.—A common cause of uneven burning is that a mining company often allows a warehouse man to pile an incoming shipment of fuse in front of the shipment already in stock. Where this is done trouble results for the reason that with age fuse slows down in burning speed. An attempt to use fuse that has been stored for months in a warehouse in combination with a fresh shipment has been known to spoil many a round of holes.

Methods and materials used in tamping cause variations in burning time as high as 80 per cent. The normal speed on the Pacific Coast is 40 sec. per foot, when the fuse is burned in the open at sea level. Investigation of reports of uneven burning time in development work brought to light a curious circumstance: In a majority of the cases investigated it was discovered that the holes that were reported to have gone out of their turn, and thus spoiled the round, were the lifters.

Questioning of the miners who had loaded and fired such rounds showed that they all believed that "the fuses in the lifters had to stand the jar and vibration of all the other holes in the same round, and for that reason should be located as deeply and tamped as securely as possible." Following that line of argument, the miner loaded the primer in the point (bottom) of the lifter and also tamped it. The lifters were usually the only holes in the round that were carefully tamped, and the placing of the primer in any one of the other holes was largely problematical, usually at some point in the hole that suited the fancy of the particular miner loading the hole. The result of this method of loading was that the lifter would fire out of rotation and spoil the round. The speed of the fuse in the lifters was governed by the pressure exerted on it for considerable length by the explosive load and the stemming. This caused rapid burning.

Although the mining company, as a general practice, should not attempt to settle the much-mooted question of the most desirable position of a primer in a hole, it should insist that, if good results are expected from safety fuse in regard to even burning, the primers in all the holes in the same round should be subjected to about the same pressure on relatively equal lengths.

Another cause for uneven burning for which the fuse is in no way to blame is the improper spacing of holes. This practice often causes holes to fire out of rotation, owing to ground squeeze created by firing holes drilled too closely together. If a mine inspector receives complaints that lifters are missing in wet ground, he should carefully determine whether too close spacing of holes, instead of defective fuse, is not responsible for the trouble. Where the holes immediately above the lifters are drilled too close to them, their bursting causes the water in the lifters to drive laterally through the fuse, in many cases destroying it. This trouble can easily be remedied in wet and damp ground by putting a reasonable burden on the lifters.

Precautions for Eliminating Misfires.—Having stated the causes of many misfires, let it be assumed that the fuse has been properly made and stored. What, then, may be done to eliminate much of the trouble? Consider first the making up of the fuse into a primer.

The first operation is cutting the fuse with a sharp instrument, square across. Never fail to cut off a fraction of an inch from the end of a fuse that has been exposed to the air for any length of time, and never cut a fuse on a slant, as this may cause the sharp point formed by this kind of cut to double over in the cap barrel. This would cause the fire from the fuse to hit the side of the cap instead of reaching the cap composition. Next, care must always be taken to press the end of the fuse lightly against the cap composition before crimping. This precaution must be used so that no air space is left between the end of the fuse and the cap composition. A large percentage of misfires in mining is caused by not following this simple but vital practice.

For crimping a cap to the fuse, only a broad-jawed crimper should be used. This type of tool seldom cuts a cap shell. In cold weather fuse should be warmed slightly before uncoiling is attempted. In outside work fuse should be protected from dampness and the direct rays of the sun when circumstances force its being exposed to the weather for any length of time.

When fuse is to be used in wet work, it is well to seal the joint of cap and fuse with a suitable preparation. For this purpose P & B roofing paint having an asphaltum base, pine tar, and Celakap are recommended as the most suitable.

Some beliefs that time and constant repetition have caused to be accepted, but which are erroneous, are worth repetition.

The exterior appearance of a fuse is often taken as a reliable indication of its quality. Fuse of dingy appearance, however, is often excellent in quality. Some grades of fuse waterproofing will absorb the white material put on the outside, causing the fuse to become a dirty yellow color. This in no way affects the burning quality. A test would easily determine the quality of the fuse and avoid unnecessary complaints. Contrary to popular belief, the center thread is not chemically treated to assist in the [illegible] quality of the fuse. The absence of the center thread will not alter the burning speed of the fuse; its function is merely to make a more certain flow of powder in the fuse-making machine.

Loosening Dirt With Scarifier in Ditch Construction, and a Land Leveling Tool

In developing the 70,000-acre tract of the Crocker-Huffman Land & Water Co. at Merced, Cal., several interesting dirt-moving methods were employed by Mr. Henry Lage, manager of the company. In building the irrigation ditches the dirt was loosened by a scarifier hauled by a caterpillar tractor. Scrapers and mule teams were employed in scooping out the dirt loosened by the tractor and scarifier. Previous to the use of the outfit, the dirt had been loosened by means of road plows pulled by mule teams. Five 16-mule teams were used in this work and each plow required three men to hold it, in addition to the driver. For the five outfits, 20 men were required, which at $2.25 made the labor cost $45 per day. The total cost, figuring the 80 mules at $1 each per day, amounted to $125. With the tractor and scarifier outfit the cost of loosening the dirt was $18 per day—the cost for the tractor and the operator.

Caterpillar Land Leveler on Road Work in Illinois

One of the greatest problems in connection with the development was the leveling of the land. Livestock was first used for the purpose, 400 mules being employed with Fresnoes. Later caterpillar tractors were substituted for the mules, one tractor being used with seven Fresnoes. The difficulty with this method was that one man was required with each scraper, and with seven men in each battery of scrapers, it was difficult to get the unity of action necessary to make the work completely successful. Mr. Lage, then proceeded to experiment and finally brought out a land leveling machine which he termed a ground plane. With this plane it is stated he was able to do as much work as he had heretofore accomplished with 24 mule teams and Fresnoes. The plane has since been developed and improved by the Holt Mfg. Co. and is now known as the Caterpillar Land Leveler.

The machine is designed and built especially for use with tractor power. In the largest size (11½ ft. leveler) the bowl is 2 ft. 5 in. high and the wings extend 3½ ft. forward. The capacity is 4 to 5 yd. The smallest size (6 ft. leveler) has a capacity of 2 to 2½ yd. The bowl is raised or lowered while the leveler is in motion by a power device, consisting of a sprocket keyed to the axle and another one running loose on the upper shaft but attached to a friction cone clutch by means of which the connection between the drive and shaft is made. When the machine is standing still the bowl can be raised by a large hand wheel. The depths of cut thus can be regulated, and the load dumped in one place or spread evenly.

Simple Method of Staking Out a Logging Spur

[illegible] of strictly temporary logging spurs are very different from those relating to permanent railroad building. A logging spur has just two conditions to satisfy: it must enable enough logs to be gotten out with the available equipment to log the mill; and it must be so placed and built that the total cost of building the spur, maintaining it, operating over it, and getting the logs to it, will be less than that of any other possible combination. Civil engineers have worked out nearly all the economical considerations affecting the location and construction of standard railroads, to a point of great refinement. But unless a civil engineer has considerable actual logging experience, he will be at a great disadvantage when attempting to build a road for logging purposes. On the other hand, a great many first class loggers, who know exactly where their roads ought to go from a logging standpoint, have great difficulty in fitting to the ground a line which will best meet the requirements, owing to lack of training in the geometrical problems involved, and insufficient experience with the instrument of the engineer. In a paper presented last fall at the 8th annual meeting of the Southern Logging Association, Mr. B. G. Pasco of the A. J. Neimeyer Lumber Co., Little Rock, Ark., described simple methods of staking out logging spurs. An abstract of the paper follows:

Within the limits of economical location and construction, it is proper to allow the methods by which the logs are to be gotten to the track to influence very strongly its location. Topographical conditions may be such that there is not much choice where the railroad shall go, but when there is a choice, it is generally best to favor the skidding.

After having looked the ground over thoroughly, and determined on the general route to be followed, the next thing is to definitely indicate on the ground the exact position of the center line of the proposed road.

This staking out of the road calls for the use of a very different set of brain convolutions from those used in selecting the general route. The determination of the location calls for all the skill and experience of the practical logger; upon the accuracy of his conclusions depends the financial success of the operation. It now remains to fit a line to the ground selected, which will adequate and economically take care of the traffic. This part of the work is more a mathematical and geometrical proposition than anything else. If it is handled competently good results are certain to be secured; if it is slighted, or done by incompetent men, its shortcomings may nullify all the good effects of the painstaking work of the man who selected the route.

The methods of the civil engineer admit of the mechanical part of location being done almost to perfection, but not every operation keeps a skilled engineer on its payroll. In the absence of such a man, the logging superintendent generally has to stake out the more difficult spurs himself.

Determining Grades.—A plan by which the boss and one man, if no more can be had, can stake out a spur, and approximate the results which would be obtained by a much more pretentious survey, is as follows: The more extensive survey if properly done will always pay for itself, if it can be had, but we are considering now a case in which the boss is short handed, and has to do the best he can.

We will assume that there is one man to help to do the work, and that there are available the following tools; 1 ax, 1 chain or tape of any length not less than 50 ft., and 1 engineer's hand-level.

Suppose that it has been decided to extend a spur over a certain ridge, and that the investigation has indicated that a certain low place or saddle is the best place to get over. The first thing one needs to know is, what per cent of grade will be possible over this hill without excessive dirt work.

Take the tools and go to the place where you desire to cross. Next cut a light stick either 5 ft. or 4 ft. long, to rest the level on. Only a very short man will need the 4-

a creek. If no one can [illegible] the road [illegible] held on top of the hill, [illegible] ready to use.

First investigate the one up which the roads have to come. If this grade can be located, the other one nearly always can; and if the main one is impracticable you don't care anything about the other side anyhow.

Let the helper stand [illegible] at the lowest point in the low place on the divide. Now step down the hill in any direction from which you can see the helper's feet, and when you think you have descended the length of your stick, stand it up and hold the level on it, and look back toward the helper. If you fail to see his feet on a level line, move the stick up or down the hill until you do. The line of the level is [illegible] 5 ft. lower than the top of the hill, if you are using a 5-ft. stick. Now let the helper stand exactly where the foot of the stick was, and drop down the hill until a level sight will hit his feet again; your staff is now on a point 10 ft. below the top of the hill. Repeat the process, keeping count of the times you move ahead, until you get down to the level of the main valley up or down which you are going to build.. Multiply the length of your staff by the number of times you have moved ahead, and you find the height of the pass, in the [illegible]. Suppose the top was 95 ft above the valley.

You are now in position to begin to figure on the grade of your line over the hill. There will nearly always be a rather sharp and narrow comb right on the ridge which will need to be cut through to get any kind of a railroad through the pass. Any deeper cut than that necessary, one will be justified only according to how much timber comes over the hill, and how much can economically be spent to reduce the grade. In this case let us suppose that you sized the situation up when on top of the hill, and decided that a 10-ft. cut would let your line through in good shape. That will leave 85 ft. to be climbed on an ascending grade. Therefore if you want a 1 per cent grade over that hill it will have to be 8,500 ft. long. If you want a 5 per cent grade, it will have to be 1,700 ft. long, and so on. As it will not generally be possible or desirable to drop down the full per cent on every hundred feet, actually the line in nearly every case will have to be quite a little longer than a straight uniform grade would require. Nearly always there will be short stretches where one will have to go level, or on a less grade than the maximum, to fit the ground so as to avoid excessive grading. Also it is always desirable to reduce the grade on all curves, to compensate for the curve resistance.

Let us suppose that in the present case it is desired to get a 3 per cent line. You will divide your 85 ft. of height by three, and find that it takes a little over 2,800 ft. of length to get down on a 3 per cent grade, even if you can get your full 3-ft. drop every 100 ft., which is not at all probable.

The next step is to investigate the supporting ground on the hill side. The hill will have to have a length of at least 2,800 ft. if you are going to work down it on a 3 per cent grade, or else you will have to have a heavy fill or trestle to let you down from the point where the 3 per cent grade would get off of the hill to the point where it would run into the ground in the valley. Of course the main ridge will have a much greater length than that, or it would except in special cases be better to go around it than to go over it, but as a rule the pass through which it is desired to run the spur will be at the head of two ravines, each of which will be flanked by smaller spurs of the mountain, and owing to the shapes of these smaller hills, it is very often impossible to get around the point of one with a railroad on any practical curve. It is therefore a case of either getting to the bottom of the valley on the best side of the adjoining hills, or if they are too short, holding the line on the slope of the main mountain at whatever elevation is necessary to pass above the subsidiary ridge. Right where the small spur hill joins the main ridge is quite often the best place to get past.

Staking Out the Line.—If investigation discloses a route of fairly good surface, not too badly cut up by ravines and smaller hills, and of sufficient length, you may proceed to locate the line in detail.

Go back to the pass and cut an armful of sapling poles about 4 ft. long, point one end and blaze two sides of the other end of each. Set two of these poles 50 ft. apart on the divide, so that they will be in line with what in your best judgment will be the proper place for the center of your road. Stand behind one and look over the other and see if with allowable curves you can make the line hit where you want it to. Next stand behind the other stake and look the other way, and see if the other side will fit the ground all right. Generally it will be found advisable to change one or both the stakes a little, to get the line of sight just where it looks the best from both directions.

Having established your center line at the controlling point, you are now ready to extend your line on each side. In order to guide the graders, etc., it is best to place a stake every 50 ft. Cut a pole about 6 ft. long, and make a mark on it at the exact height of your eye. Then measure down from the mark 1½ ft., as 1½ ft. down in 50 ft. distance as a 3 per cent grade, and make a plain blaze about the size of a dollar at the place 1½ ft. below the height of the eye. Now let the helper hold the chain by the 50-ft. mark, at the nearest of the two stakes you set at the top of the divide. You take the end of the chain and range yourself into line by looking back at the two stakes, and then set a stake either in line or to either side desired, depending upon whether you want to curve or go straight. Then both the helper and yourself move up 50 ft. more, and set up another stake. By the time you have staked a short distance you are sure to have dropped the 10 ft. which you expect to cut, so select the nearest stake to the point at which the cut will begin, and commence to work for your 3 per cent descending grade from there.

At each stake beside which the helper stands, have him hold the pole on which you made the small blaze 1½ ft. below the height of your eye, with blaze facing you. Then when you get 50 ft. from him, and sight back at his pole with the hand-level, if your line of sight hits the blaze, you are on a point 1½ ft. lower than he is, and right on a point in the 3 per cent descending grade. If your line of sight hits above the mark, swing down the hill a little; if below, get a little higher. By tracing your grade line this way from one stake to the next, you will have your 3 per cent grade all the way down the hill. Of course, you can not always get just the elevation you need, because it would make your line too crooked; where you unavoidably get too high or too low, you will have to make a cut or fill, as the case may be. You must study the ground as you come to it, and run your curves with the proper offset to get the desired rise or fall; when the ground is too badly chopped up to get a smooth line, you may run across the ridges and ravines so that when the tops are cut off and the hollows filled up, the resulting line will conform closely with the desired grade.

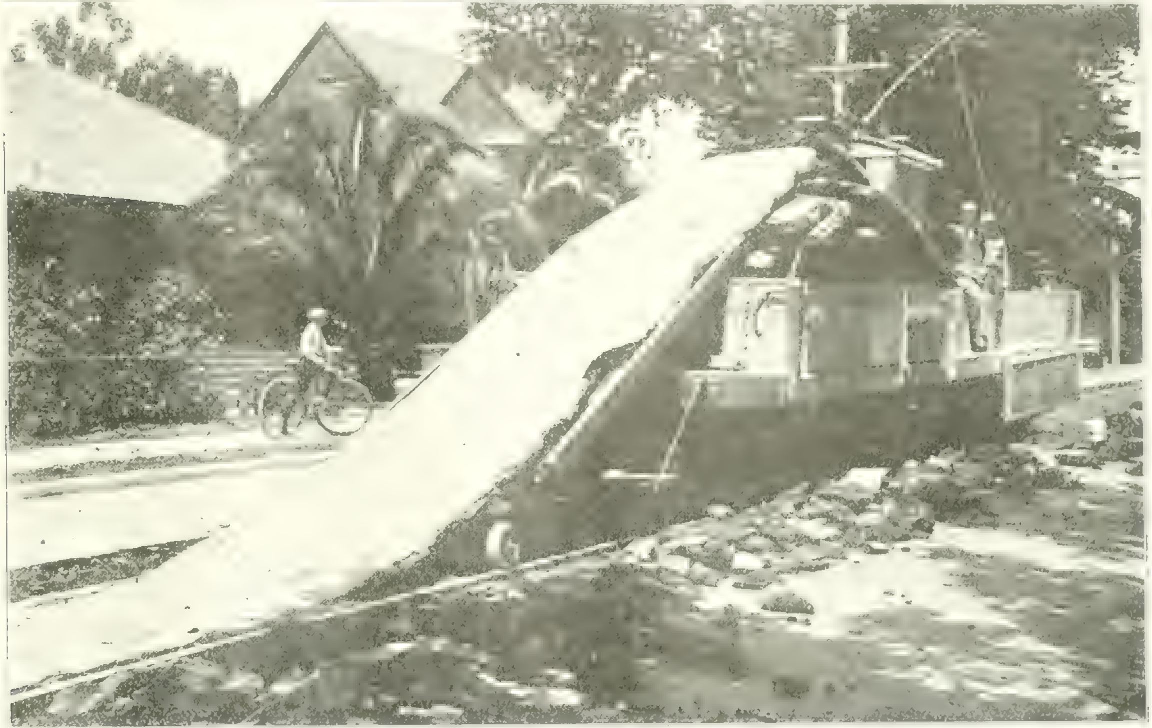
In fitting these curves to the hillside it is not at all necessary that all offsets shall be the same in any one curve. It will not hurt anything if they are all different, so long as none of them exceed the maximum around which your engines can go. The greater the offset, the nearer level you should make your grade, then when you get out of the curve you can continue to drop on your full 3 per cent.

When considering the amount of offset allowable, due consideration must be given to the type of engines to be used. There is no use to measure the offsets exactly; by some strange fatality all logging superintendents wear shoes just 12 in. long, and it has been found to be much easier and quicker, and just as good, to measure such offsets with the natural foot. Each engine will have its own limitations, and the superintendent needs to be familiar with them in order to get satisfactory results, but speaking in a very general way, one should not exceed 6 ft. offset in 50 for rod engines and 10 ft. for geared engines. Those offsets correspond roughly to a 14° curve and a 23° curve, respectively. In starting and ending a curve, always make the first and last offsets just half of what you otherwise would, to avoid having the ends of the curve twice as sharp as the rest of it.

Machine for Removing Sheet Asphalt Pavement from Between Street Car Tracks

A specially constructed machine is employed by the United Railroad of San Francisco for removing asphalt pavement from between street car tracks. The device is described in Electric Traction to which we are indebted for the matter in this article. The device is essentially a scoop or plow which is carried in front of the work car. This machine tears up the asphalt paving from between the rails and loads it into the work car as the car proceeds, the operation being continuous. The scoop or plate is 34 in. wide and 63 in. long, and is provided with a sharp and slightly turnedup front edge. The scoop is supported at the front end of the work car on a 75-lb. T-rail frame about 10 ft. in length. The upper end of this is provided with an eye which fits into the coupler on the car to be loaded. A wooden runway or platform extends from the scoop to the loading car. This platform is 4 ft. wide and 15 ft. long, and is provided with sides to guide the sheet of asphalt. It is inclined at an angle of about 25°.

When the apparatus is put in service, the asphalt at the starting point is raised slightly with bars, and the point of the scoop is forced under the asphalt by moving the car ahead. As the car proceeds, the strip of asphalt between the rails is raised up the incline and drops over the end of the platform into the car as shown in the accompanying illustration. It is unloaded at the plant and is broken up as it falls to the ground.



Self-Loading Outfit for Tearing Up Asphalt Pavement Between Street Car Tracks.

Care of Pulley Blocks.—The National Safety Council, in its practical hints for the prevention of accidents, has the following to say regarding pulley blocks: Inspect your pulley blocks frequently to see that the sheaves and pins are not badly worn or the hooks straightened. All plain-bearing sheave wheels should be oiled every day when in use on heavy work. The roller bearing sheaves should be oiled occasionally to reduce the friction wear and the danger of breaking. Oiling always lightens the work and makes it easier to judge the load and to keep within the capacity of the rope and blocks.

The Economic Duties of the Engineer*

By W. R. INGALLS,
Editor, Engineering and Mining Journal, New York

Superior to all industrial and political principles are economic laws, for it is those laws, which are laws of nature, that create and determine principles and practices. One of the greatest of economic laws is that of the survival of the fittest, which exhibits itself in competition, and from that is derived the classic economic doctrine that labor is the residual claimant upon the produce of industry. After the shares of the state, the landlord, the capitalist and the entrepreneur have been deducted all the rest go to labor, and here is what is mystifying to many—to wit, rent, interest and profits are limited by competition, and of them the laborer can get neither the share of the landlord nor of the entrepreneur by any economic means, while, as for interest, the residual claimant is benefited by every payment on account of capital used in the production of wealth, and is better off when a high rate of interest is being paid than when a low rate is paid. We may apply the principles to the concrete case of the United States.

The wealth of the United States at the end of 1916 was estimated at about \$250,000,000,000. The production of things was about \$50,000,000,000. These are very rough figures, as they are bound to be. Estimates relating to this subject vary considerably. I have mentioned the highest that I have seen. There is reason to suppose that the higher figures are more nearly correct than the lower. Anyhow, I am going to use the highest only to give an approximate idea of proportions. This was before the United States entered the war, and, according to the United States Bureau of Labor, we had 40,000,000 workers. Let us assume that rent, interest and profits averaged 4 per cent of the wealth of the nation, which would hardly be extravagant. That would account for \$10,000,000,000 out of the total product, leaving \$40,000,000,000 for labor, or \$1,000 per worker. Two million railway workers and 250,-

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*From presidential address delivered Jan. 11 before the Mining and Metallurgical Society of America.

[illegible]

[illegible] the distri-bution of wealth is not between the capitalist and the la-[illegible] clerical, shop-tending, and similar classes, and the salaried [illegible] immune.

[illegible] of the very rough statistical data that I have given, and shall [illegible] the ca-pitalist and the entrepreneur have got their taxes, rent, interest and profits, of which the last three are severely limited by competition, labor gets all the rest, and what it gets is what it produces. The only way it can get more is to produce more.

My thesis is that the only way whereby the condition of the mass of the people can be improved is for it to produce more, and the loss of capital and life that has been suffered during the last 4½ years makes it particularly essential now to give attention to increased production, to accomplish which we shall undoubtedly need to develop new systems and new methods. This is what I mean by the necessity for reorganiation, rather than readjustment, after the war. And it is in such reorganiation that the engineer must play a great part. England is already making her plans, and unless we are careful she will get the start of us. Thus, I recently noted the following paragraph in a letter from an observant American traveling abroad:

"England is knitting together for work. The directors of capital and the organizers of labor were never more together. There have been no strikes in England against capital, only against Government wages or failure of Government to equalize matters as between war bonuses and high cost of living. England is studying efficiency and is preparing for the overseas competition of the future. Forty-six English factories, without trade union or labor opposition, have adopted scientific management, but no stopwatch can be used in any factory controlled by the United States Government, nor is it allowed by the labor unions to make studies in time or motion, or to compile records to promote individual efficiency."

Now, more than ever, should labor in this country be taught that its real interest is to produce more, which is to earn more, and employers should not attempt to diminish labor's residual claim by abolishing competition among themselves or artificially enhancing profits by other means. And just as it is the interest of labor to earn the maximum, so it is the duty of the employer, which means that he should ever be alert to improve his methods of production. Wide differences of plant efficiency, administration, etc., are really the inspiration of social unrest among workers, rather than conditions that are intentionally designed to be evil. The social reformer, who does not understand production, is a far less important person in the promotion of human welfare than the engineer, who does.

First of all, what I see is that the engineer should saturate himself with sound economic doctrine. This is just as much the basis of his professional work as are the sciences of physics and chemistry; and the fundamental laws of economics are just as immutable as are the laws of gravitation and indestructibility of matter. The engineer-economist cannot possibly be a socialist, or a semi-socialist, nor even an industrial democrat; for it is his business to produce, and socialistic tenets do not tend toward production.

The engineer must be not only a counteragent against the destructiveness of the proletariat, but also must he direct himself against the sluggishness of tortoise-like capitalists. One of the cardinal principles of American engineering during [illegible] been the extension of information and the promotion of publicity about everything—technical processes, business relations, corporate affairs. We have seen America forge ahead largely owing to the absorption of this idea, while Great Britain lagged behind and almost went asleep at the switch. She is wide awake now. Let nobody forget it. But we ourselves have got to go further in publicity than we have gone heretofore. Publicity has been a favorite word among us, especially among mining engineers, who have created more openness in the affairs of their profession and their corporations than exists anywhere else. In reading one of Hobson's treatises not long ago I found a word that struck me more emphatically than publicity. He spoke about transparency, and said that "Perfect transparency of industrial operations, perfect fluidity of labor and of wealth, would effect incalculably great economies in the production of commercial wealth." And he said further: "No fact bearing on prices, wages, profits, methods of production, etc., merely concerns a single firm or a single body of workers." The more you think about that the more will you be impressed by its truth and its merit.

But while devising stimuli for the workmen let us not forget the need for opening the eyes of the employer to his own defects, and I do not mean defects in his human relations, but rather his economic defects. For an employer may be a generous and lovable captain, whom those working for him may affectionately call "the old man," and yet he may be their worst enemy, an economic impediment, owing to his ignorance and backwardness. Just as there is a class of no-rent lands which determine the price of agricultural produce, so is there a class of no-profit employers who determine the rate of wages.

Sometimes we see the backward manufacturer stirred to new and better things by the threat of imminent extinction through the advent of a new competitive process. Thus, about 20 years ago the contact process of making sulphuric acid promised to displace the classic chamber process, and abolish millions of dollars invested in plant, but the chamber-process men bestirred themselves, improved their practice, and held their own.

I think it is an indictment of the engineering societies of this country that they have made no general efforts for the advancement of economic conditions. Their meetings have been pleasant social functions, the benefit of which is not to be decried. Their printed transactions have been the repositories of valuable technical papers, which are useful for reference and guidance. But in their practical indications, in their practical push toward better things, they have been insignificant in comparison with the splendid efforts of the American engineering press, respecting which we may proudly say, "Ne plus ultra." Pray forgive any impropriety in my expressing this, for of course I have not in mind my own trifling part in what hundreds of papers have done with the co-operation of the industries and professions that they represent.

American Railway Association Reorganized.—The American Railway Association, in order to serve as a responsible channel through which the Director General of Railroads may obtain recommendations for the advancement of railroad practice during his period of federal control, has revised its articles of organization and by-laws and has changed its name to the American Railroad Association. The new association will now cover the activities of the American Railway Association, American Railway Master Mechanics' Association, Association of Railway Telegraph Superintendents, Association of Transportation & Car Accounting Officers' Freight Claim Association, Master Car Builders' Association, Railway Signal Association, and Railway Storekeepers' Association. The new organization will consist of five sections: Section 1—Operating; Section 2—Engineering; Section 3—Mechanical; Section 4—Traffic, and Section 5—Transportation. Railroads under federal control are members of the association, and will be represented and participate in the activities of each section through their proper officers.

Experience of Stone & Webster in Operation of 1-Man Trolley Cars

The one-man light-weight street car is [illegible] extensively by Stone & Webster in cities [illegible] from 25,000 to 300,000 population. This so-called safety car seats 35 persons and weighs about 13,000 lb. The results obtained from the operation of these cars were outlined by Mr. Henry G. Bradlee of the above firm at recent conference of the American Electric Railway Association. Mr. Bradlee's discussion is printed in full in the Stone & Webster Journal, from which we quote as follows:

The matter of the results obtained from the operation of these cars is very difficult to put down in black and white or in figures, because, as in all matters of the kind, results differ very much in different cities under different conditions. The question of saving, the question of how much business you may create through more frequent service, depend very largely not only on the actual conditions as to population, but also on the type of cars used previous to the adoption of the new type, the weight of car and the frequency of service previous to the change.

I think I can perhaps bring the matter out most clearly by taking the figures, which are estimates, that were made up in the early days of the operation of the one-man car, and were purposely put in very simple form. These figures have been confirmed in practice and the results which were estimated at that time are substantially those which we have actually found.

We figured out schedules for a number of lines, starting with the assumption in the first place that we were operating on those lines a 35,000-lb. car, seating 40 passengers. We assumed that conditions were the average as they would be found in a medium size street railway company. In other words, the company did not have water power and did not have the cheaper steam power which can be produced in the large cities with large size turbine units. We took the conditions as they exist in the medium or smaller size cities, operating a 35,000-lb. car seating 40 passengers.

We first assumed a line operating only two of these cars and decided we would change that to a 3-car schedule using the light-weight type of car. That resulted in this state of affairs: the schedule, in the first place, was 30 minutes between cars. With the additional car the schedule was 20 minutes, which reduced the interval between cars by one-third. The number of seats with the two 40-passenger cars was 80; with the three small type cars we had 87 seats. With this schedule we figured we were giving the passengers an increase of 7 seats, giving them a 20-minute schedule, instead of a 30 minute, and we saved per year $3,500 in operating expenses, not taking into account fixed charges.

Taking next a 3-car line and changing it to a 4-car line, three cars of the heavy type and four cars of the light, the number of seats was reduced a little. From 120 the seats were reduced to 116, but the headway was reduced from 30 minutes to 22½ minutes and the saving per year was $6,100.

Changing a 4-car line to a 6-car line gave us 174 seats on the line as against 160. This resulted in an improved headway from 30 minutes to 20 minutes and a saving of $7,000 per year in operating expenses.

A 5-car line which was changed to a 7-car line gave us 203 seats as against 200 and changed the headway from 20 minutes to 14 minutes, and saved $9,600.

A change from a 6-car line to a 9-car line increased the number of seats available from 240 to 261, changed the schedule from 15 minutes to 10 minutes and brought about a saving of $10,500 a year. These savings are just on operating expenses.

For the first case that I referred to, the investment required—these are pre-war figures and not present time figures—was $10,500 and the saving $3,500, which show that the cars would pay for themselves in about three years. In the second case the cars would pay for themselves in a little over two years—2.2 years. In the third case the cars paid for themselves in 3 years; in the fourth case the cars paid for themselves in 2.5 years, and in the fifth case the cars paid for themselves in three years.

In all these cases the cars paid for the investment—that is, paid for the full cost of the cars—in from 2.5 to 3 years, based on pre-war conditions. Just what that would mean today it is pretty hard to tell. Of course, the price of the car has doubled. On the other hand, wages are pretty nearly double under present conditions, and when you save a man's time you are saving more than you did when these figures were made. The cost of power has increased very much. I should say at the present time that where the cars paid for themselves previously in from 2.5 to 3 years, it might be from 3 to 4.5 years now.

The saving comes from two sources: first, the saving of platform labor, and second, the saving in power and other operating costs. The saving in platform labor can be accomplished equally well by taking our present cars, many of them, and changing them over for one-man operation. This has been done in a great many cases. I think we have changed over nearly half as many cars as we bought of the new one-man type.

Of the total saving, we estimate that the saving in platform labor was about 40 per cent and the saving in power and other expenses about 60 per cent, so that by merely changing from the old cars you can bring about a saving of 40 per cent of that which would be obtained by buying light-weight cars.

In the use of the light-weight cars you have the 60 per cent saving in power and other expenses, plus the increased earnings that you may obtain. There is one other feature which I think is pretty generally overlooked. I do not remember hearing it mentioned by anyone in the discussion of the one-man car problem. It is the saving in power stations and the saving in transmission systems. With these schedules as we have them here, we estimate a saving of 30 per cent in power station capacity; in other words, we are giving increased headway and we have only 70 per cent of the peak load we had before with a less number of heavy cars; or if you put it another way, having made this change and having increased the number of cars and the headway, it is still possible to increase the service some 40 per cent more before we get back to the load on our power station which we had in the first place.

So there is quite a material saving in power station capacity and transmission system cost which you can credit against any general change of this sort. Whether there is any saving in track maintenance or not, I do not think anyone can say. Of course, in running the lighter cars there is presumably less wear and tear on the track, but there are no figures available, so far as I know, that will throw any light on that phase of the subject. So far our figures are based on the matter of savings in operation, which was the thing we had in mind when we originally took up this problem—giving better service at lower cost if we could, with the idea that it might increase our earnings somewhat, but not with the idea that there would be any material increase.

The result had been quite surprising. The increased service seems to result in a very material increase in riding in a great many instances. I could perhaps give a good many more, but the following are fairly representative and will do to illustrate the matter.

In our company at Tampa we have the one-man Birney type of car on two lines. On one line the car miles have been increased about 29 per cent. This has resulted in an increase in receipts of about 13 per cent. On the other line the car mileage has been increased about 51 per cent and has resulted in an increase in receipts of an equal percentage. I would say as to these increases, that they are arrived at after deducting the normal increase, or decrease, which might have been expected without the safety cars, and measure as near as we can the effect of the car and the more frequent service on the particular lines.

In El Paso I have data for two of the lines which are operated entirely with this type of car. On one line the car mileage has been increased about 48 per cent and the receipts increased approximately 50 per cent. In the case of the other line the increase in mileage has been about

[illegible]

[illegible]

[illegible] has been 21.7 per cent and the increase in receipts, 29 per cent.

In Tacoma we have several lines. The increase in car [illegible] per cent.

[illegible] That is a smaller proportion than any of these figures show. You will notice in many of them that the percentage increase in receipts was fully equal to the increase in mileage. I am assuming now that the increase in receipts will only be equal to one half the increase in mileage.

On that basis in the first case given, changing a 2-car [illegible] a year, which combined would result in paying for the new rolling stock in a little less than one and one-half years. I will not bother to read the figures in all of these cases, but they all figure out substantially on that basis—the saving in expense plus the increase in earnings will pay for the cars in about a year and a half. That, of course, applies solely to the conditions given in these particular cases. If we had been operating a heavier car originally on the line, we would have been able to make a greater saving, and with a lighter car, a less saving. If we had taken the conditions we have in Puget Sound, where power is produced by water power at low cost per kilowatt hour, it would have reduced the savings. If the conditions had been such as they are in one of the large cities, like Boston, with large turbines producing cheaper power, it would have reduced the savings, but I think the example I have given you is a fairly typical example of what may be expected in medium sized cities.

Motor Truck Equipped for Operation on Railroad Track

A motor truck equipped with special flanged wheels for running on railroad track is being employed by Northwestern Pacific R. R. in enlarging a 1,400-ft. tunnel at San Rafael, Cal. The truck is stated to have successfully handled two 60,000 capacity flat cars and two 40,000 dump cars on a 1.2 per cent grade. The truck—a Four Wheel Drive—is owned by the railway. To fit it for this particular work it was fitted with an all-weather cab, searchlight, bumpers, couplings and railroad brakes.

Truck Owned by Northwestern-Pacific R. R. Used for Hauling Flat and Dump Cars.

Efficiency and Other Factors for Success*

By DR. LIGHTNER WITMER

Department of Psychology, University of Pennsylvania

Psychology and Efficiency. It would be difficult to state what psychology is, although I can state, in a way, what the psychologist studies. He studies just what you are compelled to study every day of your life, and that is human performance—the behavior of human beings and animals—such behavior as is accompanied by consciousness, or for the explanation of which we are compelled to assume the existence of consciousness. Such is the province of the modern science of psychology. We study mind, therefore, only indirectly through the performance of those whom we observe. When I test a student in my psychological laboratory, or when parents bring children to my laboratory for the purpose of having them examined and tested, all that my tests do is to provide a material means or agency by which I cause the child to perform in my presence, so that I can observe in a number of well-regulated tests what kind of performance he is capable of rendering.

That is the reason why psychology comes so closely in touch with human life, and that is the reason why the word "efficiency" is one which we have regularly used in the field of psychology.

Efficiency and Intelligence.—To achieve success I think that clear thinking is a very essential consideration for good work in any department, whether it be a pupil in the school or a man endeavoring to earn his living. I think certain concepts in connection with our study of human problems are coming out of this war which it is extremely important for us to try to define a little more precisely than they are defined at the present time. One of these is the word efficiency. Another very much misused term is the word intelligence. We hear of "intelligence testing" and we hear of "efficiency management." I believe that there is always one aspect of any human performance which requires us to use the term efficiency—that wherein we look upon the performance as an operation which has as its object the production of a desired result. Then we examine the expenditure of time and effort in securing that result. Efficiency exists only when the result is accomplished with a minimum expenditure of time and effort, and this relation is quantitatively measured.

The attainment of efficiency is only one way of achieving success. Another way of achieving success is through the exercise of intelligence. I use the word intelligence to mean invention—to employ the imagination to solve a new problem. In its highest manifestation it is what we call genius. In the lowest manifestation it is what we call cunning. It is possessed by the young as well as by the old, and by the lower animals as well as by man—the ability to solve some problem which confronts him for the first time.

We are confronted all the time with performances in these days where we must distinguish the relative efficiency of individuals or institutions from their relative intelligence. It has been, to my mind, a conspicuous result of the achievements of this war that the Germans, despite their greater efficiency in industrial and military organization, have been beaten by the superior intelligence of the allied peoples. To my mind it does not help us in analyzing the situation to say that because the Allies have won the victory it therefore means greater efficiency.

Efficiency, Intelligence, Knowledge, and Intellect.—Now looking at what is involved, not only in the handling of men but in the handling of students, in the arrangement of the course, or curriculum of a professional school, or in any institution where these different factors come into play: Efficiency is to be acquired only as the result of discipline through constant training and practice. It comes out of a repeated performance done over and over again until the maximum amount of output is obtained with a minimum amount of effort. We do not like efficiency really, because it exists in an atmosphere of freedom and requires us to put forth strenuous effort. We like our employes to be efficient, our students to be efficient; but, as for ourselves, we prefer to be intelligent. That is to say, we prefer to achieve success by some other means.

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*From an address presented Dec. 3 before the Engineers' Club of Philadelphia.

Success is not achieved solely through efficiency. Because American business men and American professional men achieve success and acquire wealth or obtain reputations is no proof that they are efficient. Efficiency is one thing; the employment of intelligence in order to accomplish a result by some other means is a very different matter. Those are two distinct aspects of every performance and they stand with respect to each other as though they were at quite opposite and contrasting poles. There is nothing so different from efficiency as this mental quality which I call intelligence.

Knowledge, we are told, is power. Knowledge is acquired by the exercise of the memory; which means, again, either the training of the memory and the acquisition of ideas at some relatively low level, because lower types of men can achieve it, and the employment of knowledge is therefore for the purpose of producing efficiency; or it means the acquisition of knowledge in order to get new ideas. For example, the new discoveries with respect to by-products and the introduction of by-products in the manufacturing industries, it seems to me, do not add to efficiency. It is the introduction of a new bit of knowledge by virtue of which a new line of performance is carried on.

Now, we advance constantly—we make our successes through acquiring new knowledge, and it is therefore of great importance that we should consider what kind of knowledge is to be acquired and what its results and consequences are.

There is a certain kind of knowledge which we call professional knowledge—professional skill—which comes fairly close to efficiency, but which, in its higher regions of intellectual thought, does not involve efficiency at all, but processes that had better be called imagination, which brings it a little closer to this other capability which I call intelligence. A man's knowledge may be professional knowledge and lead him to success in your line or my line of work; or, on the other hand, his knowledge may be of human character. A man may succeed as an engineer or as a doctor—not because he is a good engineer or a good doctor per se, but because he understands human nature, or can pass a good bluff, or because he has a lot of good friends.

Knowledge for Its Own Sake.—There is one kind of knowledge which I, as a university man, feel is extremely important; that is, knowledge for its own sake—the possession of a certain amount of knowledge for the sake of acquiring new knowledge—knowledge which forms a basis for further investigation. In my opinion the great advances of the world have come, to a certain extent, through men of genius, men of intelligence, who have employed in specific sciences such knowledge as they were able to acquire in order to gain new knowledge. Other persons may subsequently have carried their results to a conclusion. For example, the aeroplane was invented by an American—Professor Langley, who barely achieved success; yet, nevertheless, he did succeed. Foreigners took the idea and advanced it. It is said that the submarine is not a German invention. It is said also that the Germans did not invent mustard gas, but they took the idea and developed it. That is what I mean by knowledge further developed in the direction of efficiency, and our institutions, whether they be such as yours, or schools like the University of Pennsylvania, should be ready to develop all kinds of knowledge which may be applied, and should apply that knowledge. In addition, some corner of the institution should be reserved for those who are interested in acquiring new knowledge for its own sake; because, after all, it is such new knowledge which points the way for those who take the knowledge and employ it in other directions.

There is another factor which comes into all our work, a factor of great importance, and that is what I can only vaguely call judgment—the exercise of good judgment. Good judgment is only to be acquired as the result of experience. I can see it with every individual that I examine. It comes out in the simplest test—in the judgment which he exercises in solving the test. He must choose certain methods of operation if he solves the test which I put before him, and he will use good judgment or bad judgment in solving it.

Principles Underlying Good Judgment.—Then there are certain principles which underlie good judgment which are mainly balance and common sense.

"Honesty is the best policy," we say, and so it is. That is the ideal to make—to put before a man as his standard of living. Yet anybody who lives in the world knows that success is conditioned not only by following that policy—it is conditioned often by making compromises with it. The same may be said of lying. It is not safe to say, as Bethmann-Holwegg said, that "Necessity knows no law." As a proposition it does know no law under certain circumstances; but that is not the proposition to put before humanity as a rule of action. Judgment calls upon us to select the opposing principle of law which yet permits of exceptions. We say that we are law-abiding citizens, but each man feels he has a right within himself to annul the law when it comes to certain critical situations.

The Principle of Compromise.—It seems to me that in the selection of our rules of conduct and in the way in which those rules of conduct are lived up to, you will always find that the principle which has brought success to some men or groups of people has been the principle of compromise. And today, when we are confronted with the uncompromising attitude of some of the socialistic minorities, you can understand exactly what I mean by that spirit. Whatever we may think of their doctrines, whether we think they are good or bad, there is the additional question of our having to deal with groups who will apparently decline to enter into any compromise at all—who either want the whole loaf or none. A certain balance and judgment which I think exists in political life and in ordinary affairs is to be found in every single performance, at least as I have observed it in the laboratory—a certain balance and judgment in deciding what the course shall be. I suppose a certain amount of luck enters into it in choosing the one to be followed and those which will lead ultimately to success.

In all this, as I see the situation which comes before us, there are those two main questions; an external one of the operation or performance—the man in action and the estimate of his action as such, and efficiency is a term which relates to that; on the other hand, there is the internal—the man carries within himself certain capacities, certain abilities, which we indicate when we say, "He is an able man; he has intelligence, intellect, sound judgment."

I think it may help everyone, as it certainly helped me, if we distinguish between this external aspect of work which is efficiency and these internal attributes which may result in efficiency. A competent man—a healthy man—is not necessarily efficient. He has the advantage over the sick man in being able to develop efficiency or to be trained for efficiency. If we are selecting men on whom we are going to spend time and effort in training, undoubtedly we want to select the more competent men.

The Problem of the Schools.—Whenever I am taken into consultation regarding the question of training young men for careers by any institution, I always say to them, "If you are trying to give these men a certain amount of professional training efficiency on the one hand and skill on the other—and you wish to fill their minds with a certain amount of knowledge which you hope that they will employ, you ought to put it before them in such a way that they will employ their intelligence, so that it will not become deadened through the other kind of training, because efficiency training does deaden intelligence."

That is the problem of the school, but an equally important problem, if we are going to send out into the world well trained professional men, is to eliminate the unfit from the schools. To my mind it is every bit as important a question in college or in professional schools, as the actual curriculum and the methods of giving instruction in the institution. We must devise some method whereby we can select those men whom it is worth while to train. So that competency comes up in connection with our institutions of highest learning, just as it comes up in connection with our lower grade work.

[illegible] given for the establishment of such institutions [illegible]l, and I have no doubt at all that the American [illegible] also take that in hand. In fact, they will have [illegible] in the race.

[illegible] schools that are going to have as their main object the [illegible] knowledge for its own sake. If our college is such an institution, where intelligence is to be exercised rather than knowledge acquired, then it ought to be the college. If it is the graduate school, then it means the further development of graduate schools. I believe that all professional men can be made to understand an analysis of these different factors which make for success, and that, after all, while it does not necessarily make for the immediate success of any one particular man, nevertheless one of the most important factors in the training of the mind is to be interested in and to acquire knowledge for its own sake instead of for the sake of using that knowledge to secure wealth or success.

What to Do When the Gas Engine Balks.—The results obtained from a gas engine depends upon the skill of the operator. An unskilled man may spend more time and energy in trying to start an engine to pump water or do some other task than would be required to do the work on hand. Such delays are preventable, for engine trouble is usually due to the operator's ignorance of some of the details essential to proficient operation. Knowledge of the engine, then, is one way to conserve farm labor and avoid trouble. To supply such knowledge the United States Department of Agriculture has recently published Farmers' Bulletin 1013, "Practical Hints on Running a Gas Engine." The aim of the bulletin is to call attention to some of the common causes of engine trouble, to suggest a method of locating quickly the seat of the trouble when an engine fails to run as it should, and to offer a sort of reminder in the form of a condensed trouble chart, which may frequently be of assistance even to experienced operators

Track Arrangements for Moving Steam Shovels

Interesting information on track arrangements for the movement of steam shovels for the enlargement of the excavated area, is given by Capt. Llewellyn N. Edwards, Supervising Engineer of Bridges of Toronto, in a recent issue of The Canadian Engineer, from which the following notes are taken.

Whenever the shovel is to be transported comparatively long distances under its own power, the simplest form of track outfit consists of short sections of rails spiked or bolted upon wooden sills or stringers. The rails are maintained at proper gage by means of eye-bolts and cramps. Details of this form of track section are shown in Fig. 1. Increased distribution of the wheel loads is generally provided, when necessary, by the use of transverse "mud sills" placed at intervals under the rail sills. The safe movement of a shovel down a grade requires that the track sections be secured against longitudinal movement by the use of rail splice plates or other appliances.

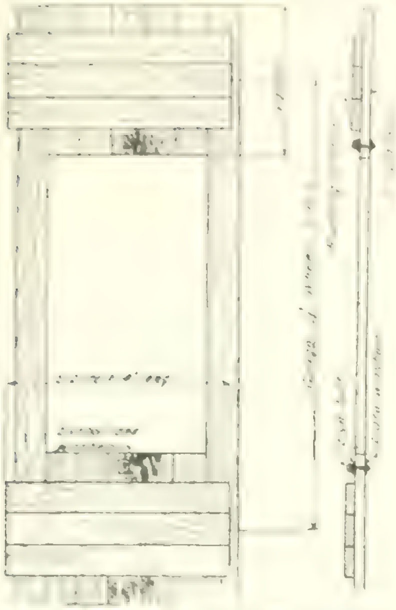


Fig. 3—Built-up Wooden Track—Planks Bolted or Spiked in Place.

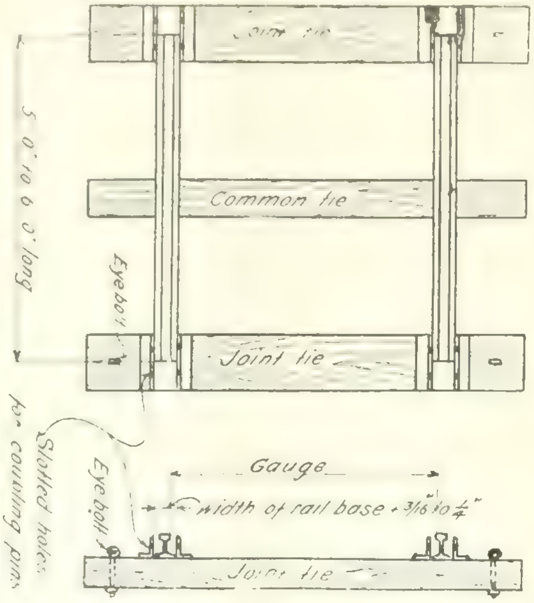


Fig. 2—Track Section for Move-up in Pit.

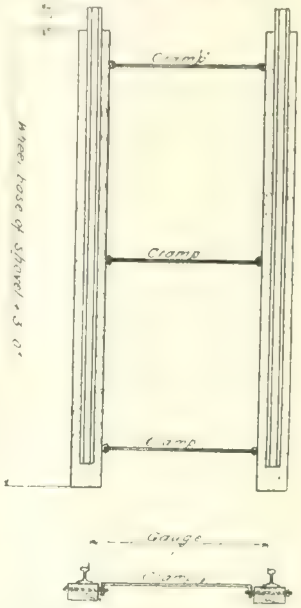


Fig. 1—Track Section for Long Distance Movements.

Economy effected by the use of track of this type, as compared with track of ordinary construction, is readily apparent.

To facilitate the "move up" of the shovel in the operating pit, somewhat shorter sections of track than those shown in Fig. 1 must be used. The length of rail is somewhat dependent upon the size of the shovel, but in general it should be equal to the length of the average "move up" distance.

The track section shown in Fig. 2 is well adapted to a wide range of service conditions. The joint ties perform a two-fold function—the elimination of splice plates and bolts and the distribution of the wheel loads over a considerable area. The rails are held in place by the rail clips and coupling pins. The holes in the rail clips should be slightly slotted to facilitate the engaging of the holes in the rails.

Movement of joint ties is facilitated by the use of hooks or other specially devised carrying devices, for which purpose eye-bolts are provided in the ends of ties.

Movements of the shovel on a wooden track are adapted to the use of shovels equipped with traction wheels. Usually the track consists of a double course of planks or lagging, the upper course of which is laid longitudinally or workwise with the direction of movements of the shovel. These are commonly called "running planks." upper and serves to distribute the wheel loads on soft or uneven ground.

The upper and lower course planks may be [illegible]tached pieces or they may be assembled into built-up track sections, as shown in Fig. 3, for use in conjunction with the shovel of the turntable class.

Whenever built-up sections are used, they are moved to and from their location in the track by being lifted upon the dipper arm, a sling chain being provided for this purpose. Doubtless the most important factor upon which the successful lifting, swinging and dropping of the track sections into correct position depends, is the expertness of the shovel operator. However, this is a detail in which a careful operator should be able to attain efficiency by a comparatively small amount of practice.

The timber used must be tough and comparatively hard. The former property prevents splitting, while the latter facilitates "skidding" of the wheels when turning the shovel or changing the direction of the cut.

Status of I. C. C. Railway Valuation Work

Progress of the valuation work of the Interstate Commerce Commission was seriously interfered with by the war. The majority of the engineers of the Valuation Division were within the draft age, and many of them were included in the draft. The active demand for various kinds of engineering service, created by the war, made it difficult to obtain and retain competent engineers. It frequently happened that 25 per cent of the engineering force was changed in a single month. The effect in the engineering section has been more serious in the office than in the field for various reasons which need not be referred to. It had been estimated that the office work would be cleaned up in from a year to a year and six months after the completion of the field work. Owing to the delays of the war that estimate must be increased by about one year.

It is now estimated that engineering reports will be filed in Washington, upon all properties, in about three years from Jan. 1 next.

The effect of the war during its continuance was perhaps more serious upon the accounting work than anywhere else. The number of accountants actually taken into military service was not great, but the activities of the war, both on the part of the government and in private enterprise, seemed to call for a great amount of accounting effort which very much increased the demand for accountants as well as the compensation paid. It was especially difficult to find accountants at the salaries which the commission could offer who were competent to make reports. With the close of hostilities this difficulty is fast passing away and it is apprehended that the Valuation Division will find it easily possible to conclude our accounting work within the time above indicated for the completion of engineering reports.

Most of the land appraisers were beyond the draft age and the war did not materially interfere with the prosecution of this branch of our work. While only about 150,000 miles of railway have actually been covered by the land appraisers in the field up to the present time, there will be no difficulty in bringing the work of that section to a completion along with that of our accountants and engineers.

It is expected, states Mr. Charles A. Prouty, director of the Valuation Division, in the Railway Age Gazette, to which we are indebted for this note, that the field work for the most part will be completed next year, and the entire work finished within the two following years. This brings the valuation work to the point where reports of all sections upon all properties are filed with the commission in Washington. No estimate has ever yet been made as to the time which may be required to adjust the objections which carriers will make to these reports, but it is believed that after a little this will go forward rapidly.

Bill Before Michigan Legislature to License Engineers.—An engineers' license bill was introduced in the Michigan Senate on Feb. 12. It provides for a licensing board of three members, appointed by the Governor. Each engineer passing his examination would pay a fee of $10, and $5 per year thereafter for renewal of license.

Governors and Mayors Co-operate to Revive Building and Construction Industries

In its effort to stimulate local and private initiative in the industrial readjustment, the U. S. Department of Labor is supporting and co-operating with many governors and mayors. Recent correspondence between state and municipal executives and the Information and Education Service of the Department discloses an enthusiastic approval of aims of the recently created Division of Public Works and Construction Developments, a branch of the Information and Education Service, which has been placed at the disposal of state, municipal and private interests desiring information on industrial conditions.

Governors Charles H. Brough of Arkansas, Marcus H. Holcomb of Connecticut, Sidney J. Catts of Florida, D. W. Davis of Idaho, Frank O. Lowden of Illinois, James P. Goodrich of Indiana, W. L. Harding of Iowa, Henry J. Allen of Kansas, Emerson C. Harrington of Maryland, Calvin Coolidge of Massachusetts, Theodore G. Bilbo of Mississippi, Frederick D. Gardner of Missouri, S. R. McKelvie of Nebraska, Alfred E. Smith of New York, O. A. Larrazola of New Mexico, Lynn J. Frazier of North Dakota, James M. Cox of Ohio are among the chief executives who are in touch with and interested in the work of the Department of Labor in stimulating public construction work.

Governor Frazier of North Dakota advises the Division of Public Works and Construction Developments his state now proposes "a permanent industrial commission shall undertake a program of public works and of state industries together with a special drive for home building and farm improvement." Governor Withycombe of Oregon writes that his state has a comprehensive road building program for this season which will employ 3,800 men. In all states where legislatures now are in session the subject of expediting public work and encouraging private building is being discussed, special attention being given to the possibilities of this public work as a stimulus to industry and its effect on the labor situation.

In his message to the California legislature, Governor Stephens emphasized the importance of immediate work on public undertakings in the following language:

"Immediate employment for our returning men may be provided by pushing forward, with utmost speed, the completion of the state highways, for which the people already have voted bonds. On this necessary work employment can be found for every California soldier who does not secure work immediately upon his return."

With reports from the industrial centers showing an increase in the labor surplus, the Department of Labor submits it is prudent for states and municipalities to be devising a way to do, what Governor Stephens says road building will do in California—provide employment for every returning soldier until industry gets back to normal.

Hon. Ernest Lister, Governor of Washington, in his message to the State legislature, made a statement of the industrial problem which is very similar to the representations now being made by the U. S. Department of Labor. He said:

"The problem of readjustment has been discussed by many persons solely on the basis of providing properly for and furnishing employment to the returning soldier. That portion of the problem involves our sense of honor. It is imperative and primary, and must have first attention. But the bringing about of such a result is only a partial solution of the whole problem of national welfare. In addition to approximately 4,500,000 men who entered the military and naval establishments proper, there are many additional millions who became a part of the great war-time industrial army engaged in the manufacture of arms, ammunition, clothing and in countless other lines of war activity. Many of the plants engaged in such production have already closed down; others have materially reduced their working forces. For the future well-being of our state and nation it is absolutely essential that those who were employed in war industries and are now or will soon be without employment, be promptly provided for.

[illegible] I believe it is our duty and responsibility so to adjust conditions that [illegible] for every [illegible] person willing to accept it.

[illegible] It is true that the nation, state, counties, municipalities and other political subdivisions, can assist greatly in [illegible] the problem. But it is equally true that the in[illegible] factory, all of whose plans were delayed by war conditions, ought now quickly to so arrange their affairs that [illegible] who desire and need it. I sincerely hope our people will not overlook this individual responsibility. They should not expect [illegible] public improvements that may be undertaken, for if this be the case the time will come when public work will cease and the labor problem will remain unsolved."

Returning the Railroads

[illegible] per cent of railroad traffic runs across state lines. If the roads return to private management the interstate authority—the Federal Government—must do the regulating, with power to revise or set aside any state regulation that trenches on the national interest. Many state regulations have trenched on the national interest—being designed for the benefit of shippers and travelers in a given region at the expense of the railroad system as a whole or of all shippers and travelers taken together.

The roads should be permitted to merge and consolidate indefinitely under Federal permission and charter. The Sherman Act, as it affects railroads, and every other statutory restriction designed to compel competition should be repealed. The object of all such restrictions is to protect the public against monopoly prices, and Federal power to regulate rates affords ample protection.

Federal regulation should proceed on the principle of guaranteeing a certain minimum return on the capital invested—say, 5 per cent—and offering a reasonable margin above that as a reward for excellence and progress in managerial efficiency.

By such an arrangement every advantage of unified operation—such as joint use of terminals, consolidated train service, and so on—could be had. The public would be protected against extortion, for rate control would be in the hands of the Government. Capital would be protected against confiscation. Labor would have an open, impartial court for the arbitration of its grievances. There would be scope for private initiative; a reward for progress. We should be saved the plague of Government ownership, under which politics would corrupt the railroads, and the railroads—with two million organized voters on the pay roll—would corrupt politics. We should escape the progressive hardening of the arteries which attends Government operation.

Plenty of people will object, including state railroad commissioners, whose functions and importance would be much attenuated. But some such sweeping reorganization of the old status is the only thing worth considering as an alternative to costly and corrupting Government ownership of the roads.—Saturday Evening Post.

English Syndicate Proposes Railroad in Mexico.—An Eng[illegible] has applied to the Mexican Government for a concession to build a railroad to connect Mexico City with Merida, Yucatan.

Cost of Constructing Street Railway Track

The following data on the cost of track work in 1910 and 1915 are given by Mr. C. K. Keen, Engineer Way and Structures, American Rys. Co., Philadelphia, Pa., in the January Aera.

Cost per foot for 1,000 track feet of double track laid in main street of eastern city of 130,000 inhabitants in 1910—7-in. 80-lb. Tee rail 60-ft. lengths, at $38.20 delivered. Steel ties 5-ft. centers. Brick paving on concrete base with granite stretcher blocks inside of rail:

	Per ft.
Engineering and superintendence	$0.16
Track labor	.57
Track material	1.51
Special work	.60
Bonding	.01
Concrete, [illegible]	.88
Brick	.30
Stone block	.18
Asphalt [illegible]	.15
Paving labor	.29
Total	$4.65

A similar job in the same city, for 800 ft. of single track laid in 1910, cost:

	Per ft.
Engineering and superintendence	$0.28
Track labor	.63
Track materials	1.88
Bonding	.07
Paving material	1.16
Paving labor	.50
Total	$4.52

The cost of three jobs in 1915 in a middle west city of 146,000 inhabitants, using 100-lb. A. R. A. low Tee rail costing $35.46 delivered, was as follows:

	5,800 track feet. Per ft.	3,1[illegible]2 track feet. Per ft.	3,232 track feet. Per ft.
Engineering and superintendence	$0.05	$0.32	$0.07
Grading	.10	.16	.07
Ballast	.59	.63	.80
Ties	.26	.27	.29
Rail	1.2[illegible]	1.31	1.17
Special work	.13	....	.17
Track labor	.29	.32	.27
Paving	1.84	1.72	1.68
Overhead and bonding	.06	.16	.12
Removal of old track..	.09	new	.15
Totals	$4.56	$4.89	$4.79

Three jobs same as above except wood block paving, instead of brick with granite stretcher block, cost:

	1,688 track feet. Per ft.	1,688 track feet. Per ft.	6,387 track feet. Per ft.
Engineering and superintendence	$0.06	$0.08	$0.08
Excavating	included in removal of old track		
Ballast	1.03	.74	1.14
Ties	.29	.22	.26
Rail	1.19	1.06	1.04
Special work	1.37	.37	2.20
Track labor	.35	.21	.40
Paving	2.97	2.15	2.38
Bonding	.01	.03	.04
Removal of old track	.26	.24	.32
Totals	$7.46	$5.10	$7.86

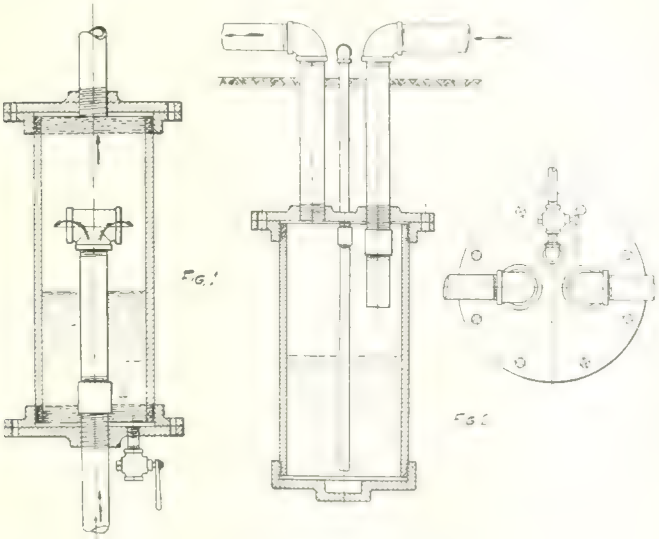
The cost of two jobs in a central southern city of 30,000 inhabitants, using 100-lb. A. R. A. low Tee rail, at $33.51 delivered, and oak ties, 2-ft. centers, brick with granite stretcher, brick inside and ouside rail, was as follows:

	24,520 ft. Per ft.	13,860 ft. Per ft.
Engineering and superintendence	$0.24	$0.26
Grading	.14	.13
Ballast	.37	.35
Ties	.30	.30
Rail	1.20	1.22
Special work	.25	.14
Track labor	.34	.29
Paving	2.16	1.97
Bonding	.04	.02
Removal of old paving	.02	.03
Removal of old track..	.21	.27
Totals	$5.27	$4.98

Unloading Bulk Cement with Power Scoop.—By means of a power scoop and bucket elevator operated by one man a concrete products manufacturer is able to unload a 250-bbl. car of bulk cement in from 3 to 4 hours. On one occasion the operator unloaded this amount in 2 hours. The elevator raised and deposited the cement in a rectangular bin from which it was removed with shovels to the concrete mixer located at one side of the bin door.

Separators for Removing Water of Condensation from Piping System of Pneumatic Tools

The effectual separation and drainage of the water of condensation from the piping system of pneumatic tools is a matter of much importance. The slugs of water frequently coming through the pipes, in the general run of plants, not only interfere with the momentary operation of tools, but cut out the valves, cylinders, and wash out the oil, seriously interfering with lubrication. The water cannot be properly taken care of merely by placing drain cocks on low points in the ordinary piping system, but should be removed by special separating tanks or chambers located at these points and near the distributing manifolds. The separators will also serve as collectors of scale and dirt coming through the pipes, and the drain or blow-out valves should be large enough to discharge these matters as well as the water. The separating chambers should be large enough to lower the velocity of the air to a point where entrained water or dirt will not be carried through with the air current, and should be fitted with bafflers or connections which will change the direction of flow, so as to precipitate the entrained matter. While the arrangement of separators will necessarily be governed by the piping layout in each individual installation, the accompanying cuts, Fig. 1 and Fig. 2, from the Standard Practice Bulletin of the Division of Steel Ship Construction of the U. S. Shipping Board, illustrate two types, which in the smaller sizes can readily be made up of standard pipe fittings. Fig. 1 shows a type suitable for vertical risers at the ship staging, while Fig. 2 indicates a type suitable for horizontal distributing lines. An air piping system should be uniformly graded with the direction of flow, so far as the main runs are concerned, and should always have separators at or near rising points. Sags or pockets without separators for the accumulation of water should never be permitted. Where it is possible to do so, separators on outdoor lines should be placed in the ground below the frost line, to prevent freezing, as shown in Fig. 2. The condensation can be blown out through a vertical discharge pipe by the pressure of the air in the separator.



Arrangement of Separators.

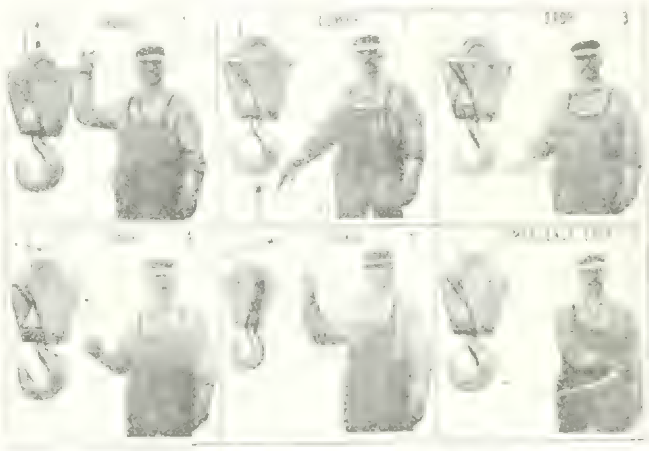
Cost of Hydraulic Dredging in Lower Sacramento River, Cal.—During the years 1916-17, the two hydraulic dredges, Sacramento and San Joaquin, operating on the Lower Sacramento River, California, removed 14,973,262 cu. yd. of material from the river channel. The average cost, according to the last biennial report of the California State Department of Engineering, was 3.1 ct. per cubic yard. These dredges are owned by the project. A bucket dredge, hired to breach old levees and to construct embankments for retaining spoil deposits, handled 1,001,782 cu. yd. at an average cost of 3.2 ct. per cubic yard.

Breaking Up Frozen Iron Ore with Dynamite

Dynamite was employed successfully [illegible] in breaking up a pile of frozen iron ore at the plant of the Pennsylvania Salt Co. at Greenwich Point, Philadelphia. The ore was piled up inside of a building, which is about 100 ft. long by 75 ft. wide. It is piled in the form of a crater of a volcano; that is, high all around the sides and low in the center. This gave opportunity for the frost to penetrate through the entire mass. The frame in which the ore was piled had at one end the engine and boiler rooms, at the other end the acid mixing tanks, along one side the long rotating mortars; overhead are automatic cranes carrying dip buckets so that they can move the ore from place to place. The other side was exposed to the open. In its endeavors to break the freeze-up the company had poured boiling water over the ore and had done everything else in their power to get it so that they could work it, but without avail. An expert blaster went there at the solicitation of the company to look over the work and see what he could do. He started on the outside lip of the crater placing about 15 charges, using one stick of 40 per cent ammonia to each charge, the distance between charges being about 2 ft. After these charges were set, great care was exercised in tamping and capping, then the men in the cranes ran their cranes out a distance of about 50 ft. The other machinery kept in motion. The men in the acid mixing tanks moved away just for safety sake. After the charge had gone off the crane returned and removed the shattered material, dumping it into the center of the crater. The blaster then moved on around the lip until he had lowered the entire circumference down to the uniform level, and kept on repeating the operation in circles until the entire 10,000 tons of ore were loosened and in working condition. The entire operation used up 450 lb. of dynamite, 900 caps, and consumed 10 days of 3 men, including the blaster. The cost of operation was $300.

Uniform Crane Signals

The crane signals shown in the illustration were recommended as standard by the Safety Engineering Section of the U. S. Shipping Board Emergency Fleet Corporation and all shipyards of the corporation were urged to adopt this standard system of communication. The signals are as follows: 1. HOIST—Forearm vertical. Make small horizontal circles with the hand. 2. LOWER—Arm extended, hand below hip, wave forearm downward. 3. STOP—Arm extended, hand level with the hip. Hold position rigidly. 4. RACKING—Arm extended, [illegible] thumb extended horizontally, jerk hand in direction of racking. 5. TRAVEL—Forearm vertical, hand open. Wave forearm in direction of travel. 6. EMERGENCY STOP—Arm extended, [illegible]. Move hand rapidly to right and left.

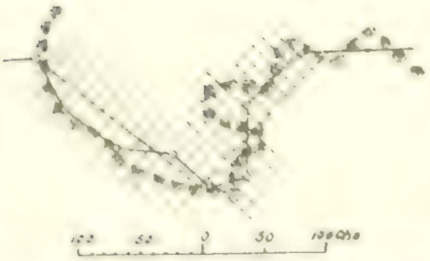


Standard Crane Signals of U. S. Shipping Board Emergency Fleet Corporation.

Use of Surveyors Compass in Preliminary Railway Surveying

[illegible]

[illegible]

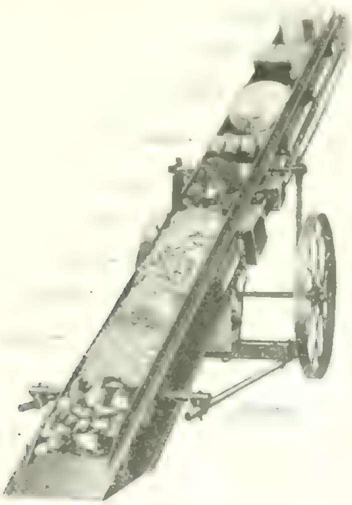


[illegible] by Means of Compass.

to get around (see illustration). We first ran a compass line in a general straight direction on one side of the hill, or plateau, and took cross section every ten chains, in most cases on both sides of the compass line. Some of these cross lines we found necessary to run up or down the grade a distance of a half-mile. The leveler followed the compass, taking levels on all cross sections also. After reaching the terminus of one side of the plateau, we turned a right angle on the other side and worked in the same way. The dotted lines every ten chains on the compass line [illegible] In camp we mapped and profiled the compass line, including the cross section. Then we had a complete plan and profile of the country and it was an easy matter to pick out on the plan a preliminary location. The preliminary is shown on the sketch. This involved a good deal of work, but it paid.

Power-Driven Portable Scoop Conveyor

The Portable Machinery Co., Inc., of Passaic, N. J., is manufacturing a new type of portable belt conveyor. It may be driven by a self-contained electric motor or internal combustion engine and is designed for unloading loose materials or boxed products, including: coal, gravel, sand, ashes, coke, brick, and cement. When handling loose materials the conveyor is supplied through a scroop at the lower end which can be placed in or completely buried into the material to be moved. A portable machine handled by one man is thus available for loading and unloading, storing or reclaiming all classes of materials. In connection with the handling of coal from hopper or drop bottom cars, the lower end of the conveyor can be run in under the car and



Portable Scoop Conveyor.

Concreting in Cold Weather and Temperature Records of Concrete

In the construction of the La Loutre storage dam on the St. Maurice River for the Quebec Streams Commission the concrete was deposited in sections varying from 40 to 50 ft. in length for the whole width of the dam. Each section was anchored into the adjoining one so that the parts constructed separately are really a unit. In the month of October, it became necessary to protect the concrete against the weather. When frost occurred at night only, it was sufficient to cover the fresh concrete, but later on when the low temperatures took place during the day as well, the concrete was given the necessary temperature by heating the water used in the mixture. This precaution was sufficient when the temperature was 8 or 10° below the freezing point. For lower temperatures, the sand and the stone has to be heated. The above rules were followed exactly for this work and the temperature of the concrete coming out of the mixers averaged 50°. The temperature of the concrete when it was setting was recorded. This was done by leaving in the mass of the masonry a small pipe well closed at its lower end and which could be increased in length so that its upper end was above the concrete. At the top of this pipe was screwed a cover inside of which was a small hook. A thermometer attached to this hook could be lowered to any elevation and the temperature of the concrete at that elevation was obtained. It was recorded, for example, that concrete having a temperature of 50° when deposited into the forms, had later on the following temperatures:

	Degrees.
First day	55
Second day	60
Third day	66
Fourth day	68
Fifth day	72
Sixth day	75
Seventh day	76
Eighth day	76
Tenth day (maximum)	80

Then, this temperature gradually decreased and the concrete set under normal conditions.

Visible Index System for Record Keeping

A visible index system has proven of great value in recording progress in various lines of operation at the Newark Bay ship yard of the Submarine Boat Corporation. The system consists of 12 boards, swinging from a standard in such a manner that each board acts like the leaf of a book. On the boards are hung small cards. There is a card for each piece in the ship. The cards bear on their faces a complete record of all shipments and receipts of fabricated ship material. Between 5,000 and 6,000 cards are required. These cards are kept constantly up to date, so that at any time it will be possible, by looking at the proper card, to tell instantly just how many of any particular piece of the ship have been shipped or received. As a concrete example, let us suppose that the production chart shows that on June 15 there should have been shipped by the fabricating shops twenty-four pieces of a certain deck beam, say DB-2R. A glance at the card for that piece shows that only 18 have been shipped, of which 14 have arrived and 4 are in transit. Naturally this constitutes a danger point, so a red flag is hung on the hook supporting the card for DB-2R. The next step is to see what shops should have shipped the piece under discussion. Of course, all material has been scheduled for shipment in such a manner that, if the schedule is met, the flow of shipments will meet the requirements of the production chart. In the case we are considering it is evident the shipping schedule has not been lived up to. Upon examination of the schedule of shipments, we find that three shops should have completed their allotment of DB-2R, but that only one shop has done so. The two remiss shippers are asked to do two things: First, get busy and ship the balance of the beams, and, second, explain the delay. Another use will be to tell instantly if a certain piece of a certain ship has been received. Suppose ship No. 20 wants a tank top plate TE-4. A glance at the card for that piece shows only 17 have been received. It is at once evident there is no use for ship No. 20 to waste time ordering that piece; it is not in stock for ship No. 20.

the material elevated from the track level, a distance 6 to 9 ft., to a storage pile. Or it can be elevated in one or more successive stages, until the pile is filled up to the desired height. In addition to handling loose material, the conveyor can also be employed for sacks, packages, boxes and manufactured products. The conveyor is built of steel and is mounted on two wheels attached to the upright supports of the conveyor. At the lower end of this upright are two horizontal pipe section members which join the side supports of the conveyer, near the lower end, the arrangement being roughly that of right-angled triangle with an extended hypothenuse. The driving motor is mounted on the horizontal support and transmits power through a chain and sprocket connection a shaft located directly above it and extending underneath the conveyor from one side to the other. Fróm a sprocket on the other end of this shaft power is transmitted to another sprocket at the upper end of the conveyor which does the actual driving. The conveyor can be moved from place to place. This is easily accomplished by inserting two pieces of pipe in the end of the horizontal member, when one or two men may move it somewhat as they would a wheelbarrow

Quarry Stripping with Drag Line Scraper

An interesting modification of the drag line scraper method of stripping is employed at a Pennsylvania quarry, states Mr. Oliver Bowles in a bulletin, "Rock Quarrying for Cement Manufacture," issued recently by the U. S. Bureau of Mines. A single scraper of ⅞-yd. capacity, working on a drag line, strips the soil back from the face The loaded scraper is dragged up a plank incline onto a trap door in the platform at the upper end of the incline. The trap door drops under the weight of the load and dumps the soil into a car on a track below. The incline and the platform can be shifted laterally as required. Two men are employed to guide the scraper during loading, and part of the time of another man is required to control the cable and place the scraper in position. The entire operation of loading required only four men, and part of the time of a fifth. Except for the engine runner, the men are all unskilled laborers. The material is handled rapidly and the cost of loading is said to be about 3 ct. a cubic yard. The loaded cars are hauled by cable to the dumping ground.

Railway Rates Should Be Based on Cost of Service Rendered.—It is notorious that the existing system of railroad freight rates is not based on this principle—the cost of service rendered being in some cases greater and in some cases less than the rate. It is further notorious that at the present time the classification of the freight itself, on which is based the charges for carrying any given commodity by rail, bears little relation to this principle. It is understood that one of the reforms being effected by the present railroad administration is a revival of these classification schedules toward a proper basis, but as yet in so far as known, no move has been made for such a revision of the freight rates as will base these rates on the cost of the service. The contention that it is impossible to decide the cost of the service rendered is a reflection on the intelligence of railway operators. If freight classification be based on the care necessary for the safe carriage of goods and the kind of equipment required for their transportation, the application of modern methods of analysis and cost keeping will readily determine cost of the service for each class, or at least a practicable and reasonable approximation of such cost. Another basis for the fixing of freight rates is that the rates shall be lower to points where there is water competition. In other words, therefore, if the rates to such points be fair for the cost of service rendered the rates to points not having this water competition must be unfairly higher, or if the rates to points having water competition are less than the cost of the service rendered—always including in this phrase "a fair profit to the investors"—then the deficiency must be made up by higher rates to the interior points.—Maj. Gen. W. M. Black, in address before the National Rivers and Harbors Congress.

Superintendents of Road Construction Wanted.—The U. S. Civil Service Commission will hold an open competitive examination for superintendents of road construction for the U. S. Bureau of Public Roads. The salaries are: Class A, $150 to $175 per month; Class B, $185 to $225; Class C, $230 to $250. For Class A applicants must have had at least 4 years' responsible charge of outdoor construction work, of which at least 2 years must have been in responsible charge of grading and simple concrete construction.

For Class B applicants must have had at least 6 years' responsible charge of outdoor construction work, of which at least 4 years must have been in responsible charge of grading and concrete construction.

For Class C applicants must have had at least 8 years' responsible charge of outdoor construction work, of which at least 4 years must have been in responsible charge of grading and concrete construction, including responsible experience in the use of heavy construction plant, such as steam shovels. Applicants must not have reached their 50th birthday on the date of examination; for Class A they must have reached their 25th birthday and for classes B and C they must have reached their 30th birthday on such date. Applications must be filed with the U. S. Civil Service Commission, Washington, D. C., before March 25.

Concrete Bank Revetment.—A new type of revetment has been employed by the State Department of Engineering of California for protecting the levees of Reclamation District No. 548 from action of the Mokelumne River. The revetment consisted of sheet concrete covering the slope of the embankment and rising in a parapet at the top, and protected at the bottom by a vertical toe wall, 12 in. deep. The parapet rises vertically 19 in. with a curved face toward the water. It serves admirably to turn back the waves running up the slope and prevents any water being driven over the levee. The length of this work was 3,310 ft., and the width on 2 to 1 slope, including toe wall and parapet, is 18 ft. 10 in.; the thickness is 3 in. Triangle wire mesh reinforcement was used throughout. Expansion joints were placed every 20 ft. The cost of the work, including grading the slope, was $4.1357 per lineal foot, or $0.2196 per square foot in place.

News Letter

St. Louis Items.

[illegible] work [illegible] that point.

M. L. Windham [illegible] of team work on the [illegible] R. R. near Go[illegible], Ill.

[illegible] East Cape Girardeau, Ill.

Geo. H. [illegible] oil lands near Fort Worth, Tex.

[illegible] he has a 19 team outfit idle at that point.

[illegible] of the [illegible] Construction [illegible]

[illegible] miles of concrete road work [illegible] east

[illegible] more.

[illegible] tion Co.

The [illegible] for putting in two concrete piers for the Frisco R. R. near Warwick, Okla.

[illegible] Sibley, Mo.

D. J. (Dave) Griffiths is back in Kansas City. His friend McMurray says he is interested in a drug store at 33rd and [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] New Florence district carried by a large vote. This insures eight more miles in Missouri of the National Old Trails road. Work [illegible]

Lieut.-Col. F. G. Jonah has returned from service overseas. He has resumed his duties as chief engineer of the St. Louis & San Francisco R. R. His jurisdiction has been extended over the [illegible] & [illegible] Railroads, with office in St. Louis. V. K. Hendricks has been appointed assistant chief engineer of the above lines.

[illegible] East St. Louis voted to pave State street from thirty-third to Thirty-seventh streets, with [illegible]. It was [illegible] St. Clair avenue, from Collinsville avenue to Eighteenth street, and Columbia place, from Illinois to Summit avenues, will be held Feb. 11th. It is planned to resurface the streets.

Street sprinkling for this year will cost the city $98,132 less than it cost last year, Director of Streets and Sewers Talbert announced in awarding contracts for the forty-two sprinkling districts. Director Talbert pointed out that this sharp reduction was one of the consequences of the ending of the war and a sign of the readjustments coming with the reconstruction era. The contractors, he said, were able to make cheaper bids because labor is more plentiful and government work no longer demands so many men and teams. The director said 701 miles of streets are to be sprinkled, the same number as last year. The average cost per mile this year, he said, is $366, against an [illegible] contracts for this year is $257,187, against a total of $355,319 for last year.

[illegible] E. KOENIG.

Personals

J. M. Kinkead, heretofore supervisor of the Pennsylvania at Altoona, Pa., has been appointed division engineer of the Trenton division.

Capt. Thomas F. Bowe, Q. M. C., Construction Division, U. S. [illegible] Port [illegible] Newport News, Va.

Maj.-Gen. William B. Black, chief of army engineers, has been appointed chairman of the Port and Harbor Facilities Commission of the U. S. Shipping Board, succeeding Edward F. Carey, who resigned recently.

F. G. Jonah has returned from service overseas and resumed his duties as chief engineer of the St. Louis & San Francisco R. R., with jurisdiction over the Missouri, Kansas and Texas and the Missouri, Oklahoma & Gulf R. R.

C. A. Geiger, formerly in charge of construction work for the Arkansas Valley Interurban Ry., has opened offices at 120 South Main street, Wichita, Kans., and will engage in general contracting, specializing in steam and electric railway work.

Maj. John S. Doyle of the U. S. Engineering Corps has assumed the duties of engineer in charge of the Baltimore district. [illegible] neer, and who will remain in the office as purchasing agent of the Baltimore district.

George H. Ruppert, who before his entry into the chemical warfare branch of the service, had charge of a sodium-ferro cyanide department of the Semet-Solvay Co., has accepted a position as advisory engineer with the Powdered Coal Engineering &

Charles W. Yeamans, assistant engineer of the Chicago & Western Indiana R. R., has been appointed purchasing agent of that road and the Belt Railroad of Chicago.

J. L. Starkle has been appointed assistant chief engineer of Group 6, Southwestern Region Railroad Lines. Mr. Starkle has been with these lines since July 1, and prior to that date he was [illegible] of the Gulf, Colorado & Santa Fe R. R. at Galveston for several years.

Willis B. Clemmitt has joined the engineering staff of the Powdered Coal Engineering & Equipment Co. of Chicago in the capacity of advisory engineer. Mr. Clemmitt was formerly assistant superintendent of the open hearth department of the Central Iron & Steel Co. at Harrisburg, Pa.

Prof. E. A. Holbrook, formerly of the Department of Mining at the University of Illinois and for the past [illegible] years superintendent of the U. S. Bureau of Mines Experiment Station at the University, has been detailed to Washington temporarily as acting chief mining engineer of the U. S. Bureau of Mines.

George W. Osgood, for the last four years chief engineer for the Hylebos Waterway District of Tacoma, Wash., has been selected by the Pierce County Port Commission to take active charge of engineering matters of the commission under Frank Walsh, chief and consulting engineer of the port district.

Louis L. Tallyn, for some years division engineer of the Delaware, Lackawanna & Western R. R., has been made acting chief engineer with headquarters in Hoboken, N. J. He succeeds George J. Ray, who has been added to the staff of A. H. Smith, regional director for six or more railroads in the eastern division. Aloysius F. Colligan has been named acting division engineer, succeeding Mr. Tallyn.

Arthur W. Thompson, vice-president of the Pittsburgh division of the Baltimore & Ohio R. R., has been elected president of the Philadelphia Co. of Pittsburgh, which controls all the public service companies in and near Pittsburgh. Mr. Thompson was graduated from Allegheny College at Meadville in 1897 with the degree of civil enginer. In 1899 he entered the employ of the engineering department of the B. & O. R. R. and in 1912 became third vice-president of that road.

Obituaries

Charles L. Millford, a contractor of Columbia, S. C., died Feb. 3, aged 45.

William J. Conway, a superintendent of construction for the Otis Elevator Co., died Feb. 6, at Dayton, O., aged 39.

John Halloran, roadmaster of the first district of the Western Pacific, including the Stockton yards, died Jan. [illegible] at Oakland, following a short illness of influenza.

Brig. Gen. James F. McIndoe, U. S. Engineers, died Feb. 6 in France of pneumonia. General McIndoe was stationed at Kansas City, Mo., in charge of Missouri River improvements until June, 1917, when he was relieved for active military service.

Daniel B. Banks, consulting engineer, Baltimore, Md., died Feb. [illegible], aged [illegible] years. He was engineer for the Druid Hill and Madison Ave. cable lines at Baltimore, and later designed and superintended the construction of the city's high pressure water system.

Carl Stradley, chief engineer of the Oregon Short Line R. R., died Feb. 11, at Salt Lake City of pneumonia. He was 53 years old, and a native of Indiana, where he received his education. He removed later with his parents to Colorado, and in 1886 began railroad life on construction surveys for the Union Pacific Company. In 1889-90, he was specially engaged in surveying the Pacific Short Line, between Lander, Wyo., and Ogden, but the proposed road was never built. In 1890, he was engaged in Parley's canyon conduit survey location for the city, and was later associated with the Ogden City engineer in important construction work. Mr. Stradley went into mining in Colorado, but returned to railroad work, becoming prominently identified with new construction along the Union Pacific line. In 1901 he was engaged in location work for the Oregon Short Line, and since that time worked steadily upward until appointed chief engineer April 15, 1911, upon the resignation of William Ashton. When the government took over the railroads, Mr. Stradley was appointed assistant chief engineer of the Union Pacific system, including the Union Pacific road, St. Joe & Grand Island, Oregon Short Line, and Salt Lake Route, under Federal Manager E. E. Calvin.

Industrial Notes

The Victor L. Phillips Company, of Kansas City, Mo., has taken over an agency for the complete line of Rex mixers and pavers for the eastern half of Missouri and also the entire states of Kansas and Oklahoma.

Wallace & Tiernan Co., Inc., 349 Broadway, New York City, manufacturers of "W. & T." chlorinating apparatus, have recently appointed David Morey, Jr., 507 Scollard Building, Dallas, Tex., their South Western representative.

The Barber-Greene Co., Aurora, Ill., announces the strengthening of its organization as follows: Mr. W. A. Buell, sales engineer, formerly conveyor engineer of the Goodyear Tire & Rubber Co.; Mr. H. W. Cudding, auditor, formerly general auditor of the Lyon Metallic Mfg. Co.

R. E. S. Geare has been elected president of the Mid West Manufacturing Co., recently incorporated. Mr. Geare is well known to the construction and power plant field in Chicago and the middle west because of his active representation of the T. L. Smith Co., Manistee Iron Works Company, Geare & Company, and others, which work he will still continue. The Mid West Manufacturing Company has located its factory in Chicago, with general offices in the Old Colony Bldg. It has acquired the sales and manufacturing rights of the "Continental" Chain Grate Stoker from the Manistee Iron Works, and the "Chaingrip" Pipe Vice and tools from the Gerolo Manufacturing Co. In addition to this the manufacture of special machines, tools and dies, rebuilding of construction and power plant machinery together with the installation of such machinery will constitute an important part of the new company's activity.

Building and Structural Issue

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Roads and Streets—1st Wednesday
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal M[illegible]

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power

Railways and Excavation—3rd Wednesday
(a) Excavation and Dredging (c) Quarries and Pits
(b) Rivers and Canals (d) Railway Construction—Steam and Electric

Buildings and Structures—4th Wednesday
(a) Buildings (c) Harbor Structures
(b) Bridges (d) Miscellaneous Structures

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Why There Should Be Technical Courts for Technical Cases, Particularly Patent Cases

If we remember correctly it was Judge Grosscup of the Federal bench who said that technical cases should never be tried before non-technical courts. He was speaking of railway valuation and rate cases when he made this sweeping and almost startling generalization. Coming from one of the most learned and oldest of judges, such a statement deserves serious consideration.

Judge Grosscup pointed out the impossibility of any man's becoming well enough informed to follow intelligently the testimony of experts in many different fields of human enterprise.

Today a judge may hear a patent case of a mechanical nature, next week a public utility rate and valuation case, next month a case involving the specifications for a building, and so on. It is manifestly impracticable for him to render decisions that are uniformly correct. Why, even to learn the full meaning of the technical terms used by experts in a bitterly contested case would require more time than is consumed in hearing the entire testimony! Yet so little do our lawmakers appreciate such facts that even when an able judge himself concedes his inability to understand all the testimony that he hears, Congress does nothing to remedy the admittedly bad condition.

We are led to make these remarks as a result of the reading of some advance sheets of a new book on Concrete-Steel Construction, by Eddy and Turner. In the appendix C. A. P. Turner, M. Am. Soc. C. E., gives a very interesting discussion of "the state of the art of reinforced concrete from the patent standpoint." He says:

"As long as courts, lacking scientific ability, reverse the scientific opinion of trained patent office examiners, they will continue to err and their decisions will continue to be a menace instead of an encouragement to progress. The patent speculator will continue as now to wax fat by the purchase of a paper patent on any commercial failure that bears a remote resemblance to any present day success. By bringing suit upon such paper patents, and persuading the court that the relic which he has dug from the graveyard of commercial failure in fact contains the original thought of some revolutionary success he secures a decree in his favor and proceeds to blackmail the public in a wholesale manner. By this process the inventor who discovered the secret of success which was in no wise suggested by the abandoned experiments of the prior art is robbed of the reward for his discovery and penalized upon the legal fiction that his present day success infringes some prior art failure. Lack of familiarity with the principles of equity is not the usual source of erroneous decisions. The difficulty lies in the inability of the court to formulate the actual state of facts in relation to the art to which the law is to be applied. . . . The remedy is obvious. The enactment of a statute requiring that the question of the validity of a United States patent shall be passed upon by a court possessing competent legal knowledge and scientific ability to understand the subject matter, just the same as is required by the existing statute as a qualification of Examiners in Chief in the Patent Office, to enable them to pass upon the allowance of patent grants. The system would then become harmonious and not be such a house divided against itself, that an unscientific court reverses the patent office expert on 10 or 15 scientific questions in one and the same decision."

Although the remedy is obvious to any technically educated man, it is not so obvious to our law makers. Nor does its obviousness cause patent lawyers to take any interest in [illegible] would be tried before a court technically competent.

[illegible]

Wherein Many "Efficiency Engineers" Are More Deficient Than Efficient

[illegible] living wage, as the [illegible] and prosperity [illegible] what G. Townsend [illegible] at the February meeting of the American Institute of Mining Engineers. It is just this sort of attitude that has brought "scientific management" and "efficiency engineers" into disrepute among workmen.

Indicative of the degree of increase that laborers should receive, Mr. Harley quotes what F. W. Taylor did many years ago. Mr. Taylor, working at the Bethlehem Steel Co. plant, increased the ore shovelers' output 269 per cent, but he raised their wages only 64 per cent. Mr. Harley also cites an increase of 169 per cent in the tonnage output per shoveler in a certain mining stope, accompanied by an increase of only 18 per cent in wages! Splendid "efficiency engineering" this, an "engineering" that gives to the workman only one-quarter of his increased output in one case, and one-tenth in the other!

[illegible] that too great an increase in wages leads to shiftlessness, this is true as regards workmen of a shiftless nature. But all workmen are not of that nature, and even those that are can be educated out of most of their shiftlessness. They can be induced to invest part of their earnings. They can be persuaded to provide better homes and more comforts for their families. They are not riveted forever to shiftlessness, and they should not be treated as if they were.

"Efficiency engineering" has consisted altogether too much in exploiting workmen. The average "efficiency engineer" has been razor-edged in cutting costs. But where has he been so keen in raising wages?

No, Mr. Harley, you are dead wrong in basing your bonus payments upon the theory that "labor should not be given too much of an increase in wages over what is recognized as a fair living wage."

In another editorial we discuss what must be done to protect workmen from just this sort of attitude on the part of employers.

Can You Suggest a Pamphlet That We Might Abstract?

The editors of Engineering and Contracting make a practice of either abstracting or reprinting in full a great many engineering pamphlets every year. It is our belief that otherwise much valuable information would never reach the eyes of our readers. We are glad to have our theory confirmed by Mr. R. Fleming in an article that appears elsewhere in this issue.

Answering his query as to how the existence of a pamphlet shall be made known, our reply is that abstracts and reviews of useful engineering pamphlets should be printed [illegible] Not [illegible] this apply to [illegible] that are new but to the best of the older ones that are inaccessible to most engineers. We shall welcome any suggestions from our readers as to new or old [illegible] that we may reprint or abstract for the benefit of our fellow-engineers.

How to Win the Support of Labor Unions for Programs of Increased Productivity

From the earliest of times organized workmen—guilds, unions and castes—have opposed the efforts of employers to increase production. Even in America where this opposition has been much less strenuous than in other countries, it has existed and still exists. Only the other day the Federal Government yielded to the demands of the railway shopmen that the piece-rate system be abolished.

American laborers are not so dull as not to realize that if their productivity increases their wages should increase. But it is clear that they are obsessed by the dread of two possible consequences of increased productivity. First, loss of jobs by some of their fellow unionists. Second, confiscation of most of their increased output by capitalists. If ever labor unionists are to be won over to an unqualified adoption of all methods and devices for increasing output, they must first be convinced that loss of employment and confiscation of increased output will not occur. How shall they be assured of protection? This question is perhaps the most important of all economic questions that confront the American people.

Protection of the rights of individuals is the leading function of Government. Yet hitherto no Government has systematically attempted to protect employes from loss of income and from exploitation by employers. We are fast approaching the day when our Government must provide this sort of protection; and if the protective measures are properly planned, we may confidently look for cessation of all labor union opposition to labor-saving machines, bonus payments, vocational instruction, and the like.

Unemployment insurance has been advocated by English unionists, and there is reason in its favor, provided the recipient of such insurance benefits is willing to submit himself to governmental training for work in fields where workmen are needed. The rapid training of ship builders and other classes of workers during the war has served to dispel the illusion that long apprenticeships are needed to develop skilled craftsmen. It has been really astonishing to see the rapidity with which difficult manual operations can be taught. Knowing, as we now do, that a man can be speedily trained so that he can pass from one craft to another, no untried theory confronts us when we suggest that the Government should not only insure men against unemployment but should train men for new sorts of jobs when the old sorts are not to be had. Fluidity, in place of rigidity, of employment will become the goal. This means an almost startling departure from precedent, but it is a sane departure and it seems to offer the only practical solution to one phase of the labor problem.

Having insured the workman against unemployment and having provided for his training in new fields, there remains the problem of insuring his securing his share of his increased productivity. This is no simple matter. Hitherto competition for employes, warmheartedness toward employes, and strikes by employes have been almost the sole instrumentalities through which workmen have been able to secure higher pay as their average output increased. That these instrumentalities have been effective, particularly in America, no student of economics can successfully refute But the fact remains that union workmen demand even greater assurance that they will secure their deserts. They ask protection when they ask assurance that larger outputs shall be followed by larger wages. The Government—that great organization for protective purposes—must provide wage protection as well as life and property protection. The Government must undertake so to order industrial affairs that employes will not be entirely dependent on competition, warmheartedness and strikes to secure their share of products.

How Many Engineers Know the Chemical Theory of Rusting?

The rusting of steel or iron is a phenomenon that [illegible] chemists for many years and even yet is not fully understood. It is now generally agreed that rusting is an electrolytic action, but to know this is not equivalent to knowing all the conditions under which electrolysis occurs. For example, a few years ago it was not known that when iron or steel is under internal strain, electrolysis, and therefore rusting, occurs with greater ease. Who would have anticipated such a fact?

In this connection it is interesting to note that rolling iron or steel often results in making it more susceptible to corrosion. At Newburyport, Mass., there is an old iron bridge a century old, yet some of its parts show little corrosion. This was attributed to their being of very pure iron, until a chemical analysis of some of the links disclosed that they were of ordinary purity and very heterogeneous. Then one of the links was heated and rolled into a sheet and exposed to the weather, whereupon it rusted quite as rapidly as any rolled iron made today. This proved that the internal strains developed by the rolling caused differences in the electric polarity of nearby particles of iron.

Since rusting is an electrolytic phenomenon it becomes of great practical importance to understand all the ways in which differences in electric polarity occur in steel and iron. These are mainly the following: (1) Presence of impurities that are electronegative to iron or steel; (2) internal strains; (3) irregularities on the surface of the metal. This last mentioned cause of rusting is fully as surprising as the one that precedes it. Why should a polished razor blade rust much less rapidly than a rough, pitted piece of steel of the same quality? The answer is probably to be found in the differences in the internal strains of adjacent hills and valleys in the surface of rough steel. If so, the third cause of rusting is met by a special case of the second. An indentation in the surface is electropositive to the surrounding metal; consequently an indentation becomes deeper through progressive corrosion, for it is the electropositive parts that are dissolved or eaten away.

Rust itself is electronegative to the metal, hence, the presence of rust causes more rust to form; one vice, as it were, begetting more vice.

How can iron and steel be made more durable by the manufacturers? First, by securing greater purity. Second, by rolling methods and heat treatment that will reduce the internal strains. Third, by rolling so as to produce a smooth surface. Fourth, by alloying with metals that are electropositive to the iron or steel.

Thus far copper has proved to be the best metal to use as a rust inhibiting alloy. Copper-bearing steel is already extensively used where rusting is likely to be serious.

Rusting can take place only in the presence of water and oxygen, and it occurs only when there exists a difference in electrical polarity. We have seen how differences in polarity occur in iron and steel. Let us consider briefly the other factors—the water and the oxygen. One-fifth of the air is oxygen. Water dissolves oxygen when exposed to the air. Most of the oxygen can be readily removed from water, and it may prove economic to do so where hot water heating systems are used, in order to reduce the corrosion of the pipes. It should be remembered that heat is favorable to such chemical action as rusting, and that hot water containing oxygen therefore corrodes iron and steel quite rapidly.

Perfectly pure water—free from acids or alkalies—will not cause rust. But the carbonic acid gas of the air is dissolved by water in sufficient quantities to cause electrochemical activity. Sea water causes rapid rusting. Even the spray that is carried inland from the sea by winds hastens the rusting of the iron and steel that it lodges upon, and this may occur 20 miles or more from the sea shore.

Iron, or steel in contact with swift running water is usually less subject to corrosion than when in contact with still water. The reason for this is not yet clear.

Where ferrous metal is submerged in water, rusting is usually more rapid near the surface of the water than deeper down. Perhaps this is due both to the higher temperature of the water near the surface and to the presence of more oxygen and carbonic acid gas in solution.

Galvanizing steel or iron serves as a protective, not only because of the protection from contact with water but because the zinc is electropositive to the steel or iron. Hence the zinc slowly dissolves under the electrolytic action, instead of the steel or iron, even where water touches both the metals and establishes an electric current.

An interesting article by H. Y. Carson will be found on another page. Mr. Carson discusses the rolling of iron or steel as affecting the rapidity of rusting.

Publicity for Engineers Through Local Newspapers

How many engineers prepare descriptions of engineering improvements for their local newspapers? Not many, we think. And yet the local paper is one of the best possible mediums for securing publicity on engineering matters. The Iowa Engineering Society has been studying this question, and as a result the society's Committee on Publicity has prepared topical outlines and directions for publicity articles on the more common types of engineering improvements in Iowa. One of these topical outlines follows:

1. General Nature—
   [illegible]
2. Made by—
   [illegible]
3. Location—
   [illegible]
4. Cost—
   [illegible]
5. Financing—
   [illegible]
6. Need for Improvement—
   [illegible]
7. Type Chosen and Why—
   [illegible]
8. Length, Size, Capacity—
   Present and future needs.
9. Materials—
   Kinds, sources, costs, why.
10. Labor—
    [illegible]
11. Methods of Construction—
    [illegible]
12. Personnel—
    [illegible]
13. Progress—
    [illegible]
14. Any specially interesting feature in greater detail.

Examinations for Highway Bridge Engineers.—An open competitive examination for highway bridge engineer to fill three vacancies in the U. S. Bureau of Public Roads, and future vacancies, has been announced by the U. S. Civil Service Commission. The entrance salaries range from $2,400 to $3,400 per year.

The duties of this position will involve the making of surveys of bridge sites, superintending the construction and inspection of highway bridges, and the design and preparation of plans for highway bridges. Applicants must show that they have at least 6 years of preliminary engineering experience or that they are graduates in civil engineering from a recognized college. They must also show that they have had at least 7 years of responsible engineering experience, of which not less than 4 years must have been in responsible bridge engineering and not less than 2 years must have been in responsible highway bridge engineering. Further information may be obtained from the Civil Service Commissions in the larger cities, or from the U. S. Civil Service Commission, Washington, D. C.

12 Per Cent of Capacity of Fabricating Shops Contracted For in January.—Activities in the structural field in January were at the lowest point in many years. The records of the Bridge Builders & Structural Society, as collected by its secretary, show that during the month of January, 1919, only 12 per cent of the entire capacity of the bridge and structural shops of the country was contracted for.

Recommended Compensation for Engineers

[illegible] of responsibility entailed or the technical training required to perform the work.

The principle of a square deal for everybody should underly all rules of compensation, and that technical men must demonstrate their worth both to their employers and to the public before they will receive the compensation due them.

This demonstration should be made by individual salesmanship and by proper methods of publicity directed by this Association to establish co-operation between employers and employes and to insure proper recognition of the service of the engineer by the public.

While salesmanship may produce results in individual [illegible] for the rank and file of engineers and desirable that some form of grades for engineering services be adopted with a minimum rate of pay [illegible]

[illegible] standards but rather indicate the rate of pay of anyone who can perform the line of work and that individual effort should be encouraged to the fullest extent and be paid for accordingly.

In the determination of a just compensation, consideration must be given to the effort or cost of the educational training, the years and character of experience in the particular line, as well as total years of experience; length of time in the employer's service; character and personality; degree of efficiency and special qualifications.

The uncontrolled law of supply and demand is not a just method by which to determine the compensation for valuable services. Therefore, steps should be taken to control its operation so that it may not become oppressive, especially in the lower grades of service.

Recommendations.—The hours of employment for technical men of grades 1, 2, and 3, hereafter defined, should not exceed 8 hours per day or 44 hours per week.

Overtime in above grades should be paid for at an increased rate.

No one in charge of engineering or construction forces should be paid less than any man for whose work he is responsible.

When by a superior's orders an employe is shifted to a point requiring him to change his place of abode, the employer should bear the entire expense of moving employe and his family.

Employes should be given national holidays and not less than one day's vacation for each month employed during the year, and provision should be made for disability due to the hazard of the employment.

The following grades should be established with the minimum rate of pay per month, as indicated:

[illegible]—$ 75.00	[illegible]	Grade 7—$ [illegible]
Grade 2— 100.00	[illegible]	[illegible]
Grade 3— 125.00	[illegible]	Grade 9—[illegible]

The above grades should represent theoretical positions of certain degrees of responsibility. The committee believes that grades 1, 2, and 3 may be defined as requiring technical experience and education, as follows:

Grade 1. A position requiring chiefly mechanical skill and little or no experience, but which, however, is desirable or necessary for the technical men to do for a short time as preliminary training for higher grades of work; or a position requiring a small amount of technical knowledge, such as may be obtained in a high school or manual training school, but without responsibility.

Grade 2. A position requiring the equivalent of a high school education as well as the elements of engineering, such as may be obtained in a night school or correspondence school, and demanding a certain amount of proficiency which would ordinarily be obtained with one year's experience, lacking a college education.

Grade 3. A position in which graduation from a recognized college of engineering is desirable for its potential value, and which requires a part of that technical knowledge; or a position requiring as much as grade 2, with two years' experience, and demanding additional technical study such as the completion of night and correspondence courses.

The committee believes that grade 4 may be described in general as a position involving responsible charge of work. Up to the time of closing the progress report, the committee has not had at hand the information necessary for completing specifications for grade 4 or for outlining specifications of higher grades.

The committee believes that the definition of the higher grades from $200 per month up, should be based in part on the additional years of experience, but it further believes that the capacity of the man to perform responsible work must be taken into account, together with the degree of responsibility in an organization.

The committee believes that in certain lines of work, definite classifications may be possible, as, for instance, in public utility, railroad, structural, municipal and state work where the character of the work is more generally standard throughout the country.

Calculation of Shed Capacity for Piers

The following calculation for size of pier transit sheds has been developed by Mr. McL. Harding, president of the Society of Terminal Engineers:

It is a good rule to plan the shed for such a capacity that it will be possible to distribute all the goods taken from one ship berthed opposite to it. This is the rule at Hamburg, Germany.

When goods are handled by hand the average height of tiering or piling is about 5 ft. It is, therefore, evident that there would be required a very large floor area to distribute and place a cargo of 6,000 tons according to the marks and crossmarks, especially in a miscellaneous cargo.

Assuming 60 cu. ft., instead of the marine 40 cu. ft., to represent the volume of one ton and 16 per cent more for distributing space, this would equal about 70 cu. ft. per ton. Six thousand tons would, therefore, represent a cubical content of 420,000 cu. ft., and, at the average height of 5 ft., would cover a space of 84,000 sq. ft.

The reason for the 5-ft. height for average tiering is that manual lifting above this height means a considerable increase in the handling expense. It is more economical to hand-truck 400 ft. than to lift 10 ft. by man power. By mechanical tiering, freight can be tiered 20 or even 30 ft. with little if any, additional expense over tiering 5 ft.

Assuming an average height of tiering at 15 ft., a building could be made 56 ft. in width, 500 ft. in length, and yet have a capacity on the above basis of 6,000 tons, at 70 cu. ft. per ton. In order to allow even more floor space for the distributing or a greater holding-shed capacity, 20 ft. may be taken as an average tiering height. A shed, therefore, 60 ft. wide, 50 ft. long and with a clear height below the girders of 30 ft., tiering 20 ft., would accommodate 8,500 tons, allowing 70 cu. ft. per ton. This, or a shed 400 ft. in length, would be a properly proportioned shed for inland river terminals. It is interesting to note that 60 ft. is the standard width of inbound railway freight stations.

If the width of the sheds can be kept within the above limits, the cost of the shed will be less than is usual, as there will be one short span only and no intermediate posts to interfere with the freight movements, which posts should be avoided if possible.

It is evident that capacity is secured by height and not by width.

Associated General Contractors' Association Select Secretary.—The Associated General Contractors of America have appointed G. W. Buchholz, recently works manager for Fred T. Ley & Co., Inc., Springfield, Mass., and New York City, acting secretary of the society, with the duties of executive manager. William A. Davis, recently of the War Labor Board, was re-elected organization manager to assist the secretary.

Simple Method for Design of Booms

By ARTHUR R. RAYMOND

In the design of a boom we have a problem in [illegible] of combined stresses. We may have combined bending, compression and torsion or, more often, combined bending and compression. I have found that most designers and most of the "practical" text books treat this problem in much the same way. The approximate formula, $S = \frac{Mc}{I} + \frac{P}{A}$ for combined bending and compression or bending, and tension is generally employed as near enough for all practical purposes. In a vast majority of problems of combined stresses, this formula suffices and the accuracy gained by using theoretical formulae is generally of the hair-splitting kind.

However, when we come to a class of work that involves the design of booms, a different condition often follows. This is true where the ratio of slenderness is large, regardless of material used; or, to state it in a different way, when the bending stress exceeds the direct stress. The nearer we approach the limiting value of the ratio of slenderness, the more in error we are in using this approximate formula. The recourse we resort to, is to use some theoretical formula which, as is generally the case with these formulae, is cumbersome and mean in applying.

I have a method which I would like to present; a method that is theoretically correct, one that is logical, simple to apply and in which the 'why and wherefore" are pronounced.

I think I can best present this method by giving an illustrative problem and by giving it in some detail, little explanation will be needed.

A boom of Douglas fir is 55 ft. long and is subjected to a direct compression of 23,000 lb. and to a bending stress due to its own weight. Neglecting any stress developed due to slewing boom and load (for simplicity), find necessary diameter.

Try boom with diameter = 16 in.

Area, $A = 201.1$ sq. in. or $\frac{201.1}{144} = 1.396$ sq. ft.

Section Modulus, $S_1 = (.098)\ (16)^3 = 401.5$.

Weight of Boom $= 55 \times 1.396 \times 34 = 2{,}610$ lb.

Assuming that Douglas fir weighs 34 lb. to the cubic foot.

Bending Moment, $M_1 = \frac{1}{8} \times 2{,}610 \times 38.9 = 12{,}700$ ft. lb.

$M = 12 \times 12{,}700 = 152{,}400$ in. lb.

Bending Stress, $FB = \frac{152{,}400}{401.5} = 379.5$ lb. per square inch.

Using a factor of safety of 8.

$379.5 \times 8 = 3{,}036$ lb. per square inch.

Ultimate Stress = 6,000 lb. per square inch.

Bending uses $\frac{3{,}036}{6{,}000} \times 100 = 50.6$ per cent.

$$\frac{L}{d} = \frac{55 \times 12}{16} = 41.25.$$

Ultimate stress for column action.

$$C = 6{,}000\left(1 - \frac{L}{60d}\right)$$

$$C = 6{,}000\left(1 - \frac{41.25}{60}\right) = (6{,}000)\ \ (.312) = 1{,}872 \text{ lb. per}$$

square inch.

$\frac{1{,}872}{8} = 234$ lb. per square inch working stress.

Total compression $= 234 \times 201.1 = 47{,}100$ lb.

100 per cent — 50.6 = 49.4 per cent available

$47{,}100 \times .494 = 23{,}280$ lb.

Direct Stress = 23,000 lb.

So 16-in. boom is O.K.

Using Rankine's Formula—

$$S = \frac{P}{A}\left(1 + \Phi\left(\frac{L}{d}\right)^2 + \frac{Cy}{r}\right)$$

Where $\Phi = \frac{1}{3{,}000}$ for column both ends round, we have,

$S = 114.3\ (1 + .001\ (1{,}700)) + 379.5$

$S = 114.3 + 194.5 + 379.5 = 688.3$ lb. per square inch.

$\frac{6{,}000}{688.3} = 8.72$ factor of safety.

The method compares favorably with Rankine's formula in this particular case. The value of the constant Φ is the influencing factor in the final result.

By using the usual formula first stated in this article, the solution would be—

FB = 379.5 lb. per square inch as found before.

The direct stress $= \frac{P}{A} = \frac{23{,}000}{201.1} = 114.3$ lb. per square inch.

Combined stress $= 379.5 + 114.3 = 493.8$ lb. per sq. in.

Ultimate = 1,872 lb. per square inch, as before.

$\frac{1{,}872}{493.8} = 3.8$ factor of safety.

Thus, it is seen that, where in reality, there is a nominal factor of safety of 8 using a 16-in. boom, there is, apparently, only a factor of safety of 3.8 figuring it by above method. And, in order to get this proper factor of safety of 8, using this method, a larger boom than is necessary would have to be used.

As a matter of interest it will be well to see how my method compares with some of the theoretical formulae commonly used.

Using the formula—

$$S = \frac{P}{A} + \frac{Mc}{I - (Pl^2 \div KE)}$$

Where K = 10 for both ends hinged

E = 1,700,000 for Douglas fir.

$$S = 114.3 + \frac{(152{,}400)\ (8)}{3{,}211 - 588}$$

$S = 114.3 + 464.5 = 578.8$ lb. per square inch.

$\frac{6{,}000}{578.8} = 10.36$ factor of safety.

Here, there is some little variation due to the constant K and to the modulus of elasticity E. The value of E that I selected is somewhat high and is what certain departments of the Government use.

I hope I have shown clearly how the problem of combined stresses presents some difficulties at times and cannot always be treated indifferently and by the use of the approximate formula so generally employed.

Applying the Working Load to Struts and Beams Before Using.—On account of the difficulty in securing suitable pieces for manufacturing the larger airplane parts and the necessity of conserving material, several series of tests were conducted at the Forest Products Laboratory at Madison, Wis., on built-up beams and struts of various designs and also on various types of splices. Results of these tests were used in preparing army and navy specifications for laminated and spliced beams and laminated struts. Two simple, non-injurious methods for determining the strength of struts have been developed and further tested for inspection work, which it is thought will considerably reduce the number of rejections under the standard method. The tests are made on full size specimens, every strut used being subjected to the standard test, which is more severe than any working load could possibly be.

Co-Operation Between Architects, Engineers and Other Technical Men

[illegible]

Architects Should Collaborate with Important Technical Societies and Government Agencies. Various departments of [illegible] the [illegible] publications that are of the greatest interest and usefulness to the architectural profession and other interested citizens— [illegible] what [illegible] being benefited. The point is, that being the case, should it not create a reciprocal obligation on our part to co-operate with these agencies, not alone by availing ourselves of the information [illegible] issued by them, but by participating as fully as possible in their activities and contributing to the results which make these publications possible.

Should we not, as many of us as can, be members of the National Fire Protection Association, the American Society for Testing Materials, and some of the other national organizations which are working for the good of us all in the various problems connected with the sheltering of humanity? And yet there are only about 50 members of the Institute who are members of the National Fire Protection Association.

I believe that there are only three who are members of the American Society for Testing Materials. At the convention in Atlantic City last June of this society, there was a report submitted from the Committee on Fireproof Construction, and on the front page it was stated that the report had been prepared in collaboration with representatives from eleven important national organizations, which were listed, and, in the list, was not included the name of the American Institute of Architects.

Surely such a society is one which our members should join in force and in which we should make our influence felt by serving, not alone on that committee, but on the many others concerned with building materials and methods.

It seems to me that we have ourselves largely to blame that we are not more generally asked to participate in these and other public service movements, for we have not heretofore made sufficiently apparent the inclination to do so. So, I am going to urge upon you all to seek the opportunity to extend the architect's service by collaborating with these important agencies throughout the country which are doing work of so much benefit to us, individually as well as collectively.

Architects and Government Publications.—Mr. Jensen very [illegible] do to assist the United States Department of Agriculture in respect to what we have heretofore denominated minor structures of the country—farm houses and groups of farm buildings. How few of us are aware that the Department of Agriculture will provide information and furnish publications to any architect or citizen of the United States who asks for either. Many of the excellent publications are absolutely free and others may be had at merely nominal prices. It seems to me we should acquaint ourselves with the service which this department renders and the publications which it issues, and that in the case of the latter we should use as many of them as we can, should renew them, and wherever possible, offer suggestions for their amplification, improvement or greater distribution and utilization.

The same department has prepared an elaborate and most interesting model of a farmstead, showing all the buildings of such a group as well as the layout of the grounds. Why should we not get in touch with the Department of Agriculture and offer our services in further development of this idea and see that such models are given the widest circula[illegible] possible."

The same thing applies to the Bureau of Education in the Department of the Interior. That bureau not only issues comprehensive publications relating to schoolhouses and all educational matters, but has prepared drawings for schools for the smaller communities of the country. I wonder how many of the architects know that such drawings have been prepared, that they are available to, and are secured and used by school boards and communities? Why should we not co-operate with the Government in the issuance of such drawings, if they need improvement, and, if not, at least let the department know that we are with it in this movement? It also has prepared a model for a schoolhouse for a small community, and that model is being asked for by school boards in various parts of the country and has doubtless proved very helpful to them in arriving at conclusions.

The United States Department of Labor and the Bureau of Mines have both made investigations into the subject of the housing of employes for many kinds of industry, and they have issued valuable publications relating to this subject which includes a monthly bulletin of the Bureau of Labor Statistics. I do not know how many architects are aware of these facts or whether they have applied for any of those publications, but if not, they should.

The Navy Department issues specifications for materials that are used in many features of building construction. These we should know of, and benefit by the results of these investigations.

In these and many other ways we should recognize what is being done for us by the various departments of our own Government, and afford them the realization that, as citizens, we are utilizing the results of their endeavors and are willing also to assist them in every way we can.

Co-operation with Engineering Societies and Other Organizations. Among other things we should, it seems to me, co-operate with the American Society of Civil Engineers and other great engineering societies far more than we have ever done. In recognition of the important developments in materials and appliances which they have brought about we should voice our desire and willingness to take a more active part in such work.

We should also maintain a more cordial contact with, and give encouragement and assistance to, such organizations of producers and manufacturers as are constantly and conscientiously endeavoring to improve materials and processes and bring about a better understanding of their varied characteristics.

And, at the same time, I want particularly to mention the necessity for correcting the lack of co-operation on our part with the craftsmen, mechanics and others employed upon buildings. In this connection the American Federation of Labor maintains a Building Trades Department, composed of 19 organizations known as "Internationals," with local branches, in different parts of the country covering the various industries that pertain to building construction. These concern themselves, among other things, that we ought to know more about, with methods of safety in construction and the use of building materials.

Other organizations exist whose chief function is to make for safety in all the industries and in all walks of life. Among these are the National Safety Council, the American Museum of Safety, the Workmen's Compensation Service Bureau, with the valuable work and publications of all of which we would do well to familiarize ourselves.

The National Education Association is another one of the bodies which is working for the safety of occupants in buildings and is one which has a Committee on Standardization of School House Construction and Planning. The same thing applies in the matter of co-operating with the Public Health Association and with the American Hospital Association, the latter of which has a Committee on Standardization of Hospitals. No architect is on that committee, and, doubtless, but few know of its existence. We should, it seems to me, co-operate with the American Medical Society. The same thing applies to the Chamber of Commerce of the United States, the national organization representing all local groups. Heretofore we have seemed to avoid connection with anything which implied a contract with commerce, but the [illegible]

As an instance of the [illegible] simi-lar endeavor, take the case of the conference recently called by the American Civic Association and the American Housing Association.

Certainly none ought to be more interested than architects in those allied activities and yet these conferences were held in Philadelphia recently and they both covered ground already covered by the American Institute of Architects and by its Journal. These associations, apparently without notice or conference, were the initiators of a movement which should have been initiated by the architects and carried out in co-operation with these associations.

Another organization with which we have interest in common is the National Association of Real Estate Boards, and there are still many others which I can not attempt to recall in the course of an impromptu summing up of such an important sphere of activities. In concluding this outline sketch, however, I would like to make mention among them of the Illuminating Engineering Society. That organization has prepared a code for the adequate illumination of industrial buildings, and is now working on other codes, one of them being for the proper illumination of school buildings. These codes concern themselves, as is perhaps not so generally understood, with the proper day-lighting of interiors, as well as with their artificial illumination by various methods. Certainly the architects of the country should be more familiar with these works and become, in large numbers, affiliated with that society. This, like several of those of which I have mentioned, is not subject to any restriction as to membership except the indication of a resonable degree of interest and the payment of nominal dues.

In suggesting these as a few possibilities in the way of an extended national service, let me emphasize once more the impression which such service would be bound to create upon other groups and upon the public at large. I would convince them that we are persons interested, not alone in matters of design, of ethics and of pleasing disposition of materials employed in construction, but that we are also essentially interested in all matters which make for the health, the safety and the comfort of the occupants of all buildings. That we are concerned with the width and arrangement of streets, the light and air admitted to buildings, their sound and fire-safe construction, ample exits for safety from fire and panic, matters of proper sanitation, and with everything else which makes for decent places in which to live and work, and such facilities for play, recreation and enjoyment as shall make life worth the living.

$1,000 Prize Offered for Best Essay on Labor Subject.—The National Industrial Conference Board, Boston, Mass., has offered a prize of $1,000 for the best monograph on any of the following subjects:

A practicable plan for representation of workers in determining conditions of work and for prevention of industrial disputes.

The major causes of unemployment and how to minimize them.

How can efficiency of workers be so increased as to make high wage rates economically practicable?

Should the state interfere in the determination of wage rates?

Should rates of wages be definitely based on the cost of living?

How can present systems of wage payments be so perfected and supplemented as to be most conducive to individual efficiency and to the contentment of workers?

The closed union shop versus the open shop: Their social and economic value compared.

Should trade unions and employers' associations be made legally responsible?

The committee of award is composed of Frederick P. Fish, of Fish, Richardson & Neave, Boston, chairman of the National Industrial Conference Board; Dr. Jacob Gould Schurman, president Cornell University, Ithaca, N. Y., and Henry R. Towne, chairman Yale & Towne Mfg. Co., New York City. Manuscripts must be mailed on or before July 1 and further details of the contest may be obtained by addressing the board at 15 Beacon St., Boston.

From a Structural Engineer's Note Book

[illegible]

The following simple method for finding the equivalent direct stress in a compression member due to transverse loading was handed the writer at different times the past year by two engineers, neither of whóm had ever seen it in print.

[illegible] compression member [illegible] truss, be loaded transversely:

Let M = bending moment produced by transverse load,

S = maximum stress produced by transverse load,

Then SA = equivalent direct stress, but

$M = \frac{SI}{c}$ (the ordinary flexure formula) and

$I = Ar^2$

$M = \frac{SAr^2}{c}$

and $SA = \frac{Mc}{r^2}$

* * *

Some of the most frequent numerical errors are:

1. The decimal error; that is, a misplaced decimal.
2. Omission of the factor or divisor 2.
3. Error in the sign; that is, using the plus instead of the minus sign and inversely.

Omitting entire terms of smaller magnitude.—Steinmetz, "Engineering Mathematics."

* * *

As Bacon said of death, so it may be said of this evening's subject: Men fear it as children fear to go into the dark.—W. A. Green, "The Differential and Integral Calculi for structural Engineers" in "The Concrete Institute, Transactions and Notes." Vol. V, April, 1915.

* * *

Not one engineer in a thousand ever requires to make use of any mathematics beyond an elementary knowledge of the calculus, but any one who wishes to get beyond the kindergarten stage of the principles that underlie engineering work must have such an elementary knowledge. The labor spent in acquiring sufficient knowledge of the calculus to enable him to solve practically all the problems he is likely to come across, can be acquired in a fraction of the time that he would have to spend in dodging it by some roundabout process.—Goodman, "Mechanics Applied to Engineering."

* * *

Care should be taken not to divide by zero inadvertently. The following fallacy is an illustration:

Assume that $a = b$.
Then evidently $ab = a^2$.
Subtracting b^2, $ab - b^2 = a^2 - b^2$.
Factoring, $b(a - b) = (a + b)(a - b)$.
Dividing by $a - b$, $b = a + b$.
But $a = b$,
therefore $b = 2b$,
or, $1 = 2$.

The result is absurd, and is caused by the fact that we divided by $a - b = 0$.—Granville, "Differential and Integral Calculus."

* * *

Finally, brethren, saith the preacher, arrive at some definite [illegible]

* * *

However suspicious we may be of this design, there is the unanswerable argument that the bridge is standing and carrying its intended loading, and this is true of most of the reinforced concrete work in Europe. As long as their structures stand, these continental concrete specialists have somewhat the better of any argument concerning their daring efforts.—Editorial, "Engineering News," Nov. 30, 1911.

* * *

We could not be too strongly influenced by designs of [illegible] The Water [illegible] Weekly.

* * *

[illegible] has given a practical [illegible] the erection of large [illegible] Engineering. [illegible] Boston, [illegible]

* * *

[illegible] understood as a [illegible] a most able and wonderfully conceived discussion of this subject, tells [illegible] and closes by saying "The best course in practice is to assume a depth for the keystone according to an empirical rule, founded on [illegible] of bridges." We might inquire here how the old arch-builders came anywhere near safe dimensions. Did they understand the theory of the [illegible] failures or disaster [illegible] and we now profit [illegible] We must do the best we can, but be sure of being on the safe side.—Patton, "A Practical Treatise on Foundations."

* * *

You Will Be Able to Talk Confidently and intelligently on latest developments of the War, Politics, Science, and Invention, Religions, Literature, Sports, Drama, and other big subjects, if you will spend two hours' spare time weekly in [illegible] from an advertisement in an Elmira street car.

* * *

Our British technical literature is often considerably vague, to use the words of the Premier. Unfortunately, our technical literature does not contrast favorably with American literature in this respect. To return to the subject of failures, the Americans glory in the records of their failures, and learn by them. Do you hear of a failure here? Lots of you could say, "No." "Why? Because they are hushed up. In America we have them recorded faithfully, and I think if we could take a leaf out of the American's book and report in full detail it would be a tremendous advantage.—W. A. Green, "The Concrete Institute, Transactions and Notes." Vol. V, April, 1915.

* * *

The [illegible] have long maintained a policy of silence about their engineering failures. During the progress of construction of the ill-fated Tay Bridge two of the eleven 245-ft. spans were blown over. All the London "Engineering" had to say about it was the following:

"Accident to the Tay Bridge. During last Friday night the Tay Bridge was subjected to the action of a most violent storm which resulted in an amount of injury which was at first thought to be very great. It has since been found, however, that the sum of £3,000 will probably cover all the [illegible] bridge has sustained. Two girders of 245 ft. in length, and weighing together about 400 tons were in process of being got into position when the storm arose. They were both blown into the river below, and in falling they did a certain amount of injury to the rest of the structure in their immediate vicinity. Contrary to the opinion entertaned on Saturday, it is said that it will be quite possible to have the bridge completed and ready for use by the first of September."

$500,000,000 Building Deficiency in 6 States.—Building construction in 1917 and 1918 in Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and New York, was $500,000,000 below normal, according to a survey completed recently by the U. S. Department of Labor. This figure was arrived at by comparing the building permits issued in various cities in those states in 1914-15 and '16 with those issued in the war year of 1917 and 1918. The deficiency in New York state amounts to $236,000,000, while in Massachusetts the deficiency was $214,000,000. Maine, New Hampshire and Rhode Island were each $8,000,000 below normal and Vermont was about $5,000,000.

Periodic Inspection of Bridges

Most railway companies make more or less regular periodical inspections of their bridges. These inspections, however, are sometimes made by inexperienced men, and even competent engineers, not fully appreciating the importance of the task, often make such inspection perfunctory rather than thorough. The necessity for making careful examinations of such structures was pointed out by Mr. Herbert C. Keith, in a paper of unusual excellence presented some months ago before the Brooklyn Engineers' Club. The portion of the 48-page paper relating to inspection methods is reprinted below:

Frequency.—With regard to the important question of suitable frequency of bridge inspection it may be said that the author's experience gives emphatic support to two years as, in general, a satisfactory interval between inspections, though in certain individual cases greater frequency is desirable. Highway bridges are more likely to be included in such special cases. A few bridges (but only a few) may not need careful inspection as often as once in two years; such can be passed over quickly by the engineer on his biennial trips, unless need for greater care is observed.

General Information.—Several matters other than the condition of the structure are to be observed and recorded in the inspection of a bridge, as bearing on the question of its use; such as the—

Location of the bridge and what is crossed,

Date of inspection,

Type of bridge and for what it is used (railway only or highway),

Number of tracks and their location (eccentricity of track may be a serious matter),

Skew if any.

Alignment and grade on the bridge and on the approaches,

Distance from the floor to the ground or water below, with the depth of water if any,

Any special characteristics of the locality that would govern possible changes that might be needed; as the distance and direction from the bridge of any highway, railway or private crossing; also of other bridges near, which might limit the possibility or advisability of change,

Clear span and length over all.

Substructure.—The inspector notes the kind and quality of substructure with a general statement of its condition, followed by more detail as to any respect in which the condition is not wholly satisfactory, such as abutments crowding against the bridge, or dirt collected on the bridge seats. Short parapets may allow the fill to run down on the bridge seats around the bridge. Piers are sometimes too thin to take the longitudinal thrust to which they may be subjected, either from an arch or diagonal bracing or from the effect of grade or tractive or braking force.

The location, size and extent of cracks should be noted as well as the kind and extent of any other evidence of settlement, which occurs frequently because of insufficient bearing power of the soil; on high trestles, such a settlement is a very serious matter. It is surprising how often abutments and piers are built directly on the bed of a stream without any excavation and with no protection from scour. In such cases evidence of undermining may be looked for, especially at the downstream end. The best prescription for this disease is "rip-rap ad lib." In deep water rip-rap around pile foundations is likely to settle at the lower end, leaving piles deprived of their stiffening; in such cases additional stone must be dumped in or carefully placed, as specific conditions may indicate. If the substructure is of concrete, crazing (due to the shrinkage in setting) should not be confused with cracks which, however small, suggest a settlement of the foundation.

Concrete Masonry.—The surface of concrete abutments may be scaling off because an extra finishing coat was given when the abutments were built, or because of freezing or subjection to undue temperature changes before hardening. Such scaling should be distinguished from disintegration of the concrete, which is frequently found between high and low water levels in our latitude (especially in tidal streams containing sewage or chemicals); or which may be due to lean concrete, a poor mixture, or a failure to make proper bond between the concrete laid on different days. In the former case, the condition is not likely to grow worse rapidly or to be very serious; in the latter, seeds are present [illegible] may have disastrous results. In a certain concrete abutment on a tidal stream receiving both sewage and acids from a large brass factory, the face of the concrete was found to be disintegrated for several hundred feet in length of abutment and wing-wall; this disintegration extended through most of the height from low tide or the mud-flats to high water level, and in some places was effective 3 ft. in from the face of the wall.

In reinforced concrete the placing of the rods is sometimes carelessly done, leaving outside of the reinforcing rods only a thin layer of concrete, which breaks away leaving the rods exposed to the weather; or cracks may develop which in time will promote corrosion, though the alkali of the cement is a temporary protection. When rusting starts, the expansion breaks up the concrete and holds the moisture to continue the destructive work. Long before the rods are rusted away they lose their bond with the concrete and cease to work with it. In the early days of reinforced concrete a Melan arch foot-bridge of about 50-ft. span was erected over a stream at the entrance to a beautiful glen near a famous summer resort. Marble tablets in the spandrel walls give the name of the donor, who had not only provided easy access to the glen but added another charm to the landscape. When last seen by the author about 6 years ago, the contour was more suggestive of a snake than a smooth elliptical curve; and the location of each I-beam rib was strikingly apparent. Though enough steel was used to have made a substantial bridge without the concrete, this bridge is reported to have given up the struggle for existence a few years ago.

But concrete is not the only masonry that may disintegrate. Boulders of sandstone, limestone or shale often crumble away leaving aching voids, or may break for lack of strength. A certain long viaduct of several arches of limestone lost huge flakes of stone from the intrados of the arches, the maximum dimensions noticed being about 15 ft. in length, 5 ft. in width and more than a foot in thickness.

If a steel trestle post is found to have a base which holds water, the pocket should be filled with rather rich concrete (say 1:2:4), the top finished with neat cement troweled smooth on a slope to carry the rain outside of and away from the pocket. Great care is necessary in doing this job, especially that the change from concrete to neat cement be gradual, to avoid cleavage between the two parts, in order that the work may be both durable and effective.

Timber Trestles.—In pile or frame trestles decay may be expected to show first near the surface of ground or water, in tidal water chiefly just below high water level. Bark left on piling hastens decay, though in teredo-infested localities this is offset by the protection afforded by the bark against the ravages of that pest. Sills or mud-sills if buried in the ground may be expected to be shortlived. Ignorant men sometimes build up a little dam of concrete around a timber sill laid on a masonry pier, thus making a trough which holds water against the sill, hastening its decay. Dirt and dampness are the foes of timber and steel, as they are of human life; and decay, once started, progresses with increasing speed. Detailed record should be made of the location and extent of such decay.

Timber piles and posts in sea water are examined between high water level and a little below low water level for damage done by teredo or limnoria. As the holes made by teredos are very small at the surface and easily filled with moss or barnacles, their presence is not readily distinguished. A sharp blow with a moderately heavy hammer may reveal a badly riddled pile, but the only really satisfactory test is by boring, the hard lining of the teredo-run becoming evident to the augur. Though the teredo is very small at the time it enters the timber, making a surface hole only about 1/16 in. in diameter, it grows to a diameter of about ⅜ in. and a length of 10 to 15 in. Having once entered a timber, it never again comes to the surface or crosses a crack; for this reason bark, so long as it adheres firmly to a pile, may serve as some protection. The teredo may entirely eat away the interior wood, passing up and down the pile, leaving nothing solid in its place except the silicious linings of its own furrows; but it will never cross its own path or that of others of its kind. The principal other timber pest in sea water, the limnoria, is about the size of a grain of rice; but where present it is found in great numbers. It makes a hole about ⅛ in. to 3/16 in. diameter, whether at the surface or in the interior of the wood, so that its work is easily discovered. In waters infested by either of these pests, timbers should be given as great protection as possible, as a pile may otherwise become unsafe in less than two years. Thoroughly impregnating with creosote is somewhat effective as a decided deterrent, though not a sure preventive. If any method of encasing the piles is used, the casing should be carried at least 5 ft. below low water level and somewhat above high water level. The best protection where practicable is a fill of earth or concrete to somewhat above high water level, facing with rip-rap if necessary to prevent scour. When the pests are found the extent of their ravages should be thoroughly investigated and recorded.

On land, white and black ants are sometimes as destructive as the teredo and limnoria are in sea water. But the chief cause of danger to timber on land is rot, which is a fungoid growth promoted by heat and moisture; as the presence of air is also necessary to the development of rot, timber permanently submerged in water free from animal pests may endure for ages. Changes of temperature and dampness increase the rapidity of decay, so that piling and other timbers rot more rapidly near the surface of the ground or water than above or below that level. Even "dry rot" is caused by dampness, usually aided by warmth.

Superstructure.—It is in the examination of the superstructure that the greatest care and ingenuity are required of the inspector. He makes note of the style and material of the structure, and if plans are available the structure is compared with them; if there are no plans careful measurements are made in order that there may be no uncertainty as to any critical detail. When full detailed plans are available and the design and general dimensions are found to agree with them, it may still be that members have been misplaced or some other error made in construction or erection. Rods or eyes-bars may have been transposed or wrongly assembled on the pins. A strange error once observed was the transposition of the tension and compression members of a panel, they being of angles of the same size, but one pair laced, and the other not. Joint details are also sometimes varied from the plan, perhaps even differing at the two ends of a truss or in two trusses of the same span which should be alike. Washers are often omitted or misplaced, whether in the form of loose filler plates or spacing rings on pins. Double, plugged or "unfair" rivet holes are not infrequently found. Often difficult driving of rivets has been avoided by substituting bolts or omitting them altogether. Perhaps the difficulty of driving a pin has led the erectors to leave it so that the members do not get full bearing; this is more often found where solid pin-nuts are used than with lomas-nuts. Such are some of the faults which the inspector must be on the alert to observe.

Excessive deflection or vibration of a bridge or any member is recorded in order that the cause may not be overlooked in the subsequent investigation. Two bridges, originally equal in carrying capacity but differing in rigidity, will naturally differ in durability, since great movement will tend to wear out a bridge. Besides, the alarm which excessive deflection or vibration excites in the ordinary observer cannot be ignored. In 1885 one of the selectmen of a certain town took an engineer for a drive. On approaching a long, lenticular truss bridge the selectman casually remarked that the bridge was reputed to be unsafe and was causing him much anxiety; so they got out to look at it. A Newfoundland dog trotting across the bridge set the lateral rods of the main trusses to rattling against each other with a loud clatter. As there seemed to be no serious structural defect in the bridge except shallowness of some parts of the floor system, the engineer willingly submitted to the pumping process and suggested putting clamps at all intersections of light rods. The was done and the bridge is now giving satisfactory service with no change except a heavier floor system and ordinary repairs; the loads carried are far heavier than were dreamed of in 1885, and all alarm about the weakness of the trusses subsided long ago.

The inspector must note the exact arrangement of rivets at joints, especially those subject to reversal of stress, in order to determine whether the effective section of the main mem-

[illegible]

[illegible] are places where the shopman likes to substitute [illegible] is usually an inferior article.

[illegible] in small trusses rarely have their parts brought together to efficient contact, so that when not fully spliced the value of the joint is less than intended. The words "faced joint" look [illegible] share."

On a moving bridge the inspector notes the distance between the moving and the fixed parts, especially the space between the ends of rails. It is also necessary to ascertain the amount of overhang of the floor from the center of the end floorbeam, and the difference of level of the floor, as will be discussed more fully under the head of Investigation. These details frequently differ from their representation on the plans.

Protection of Steel Work by Paint.--The matters pertaining to design and construction thus far discussed are matters which do not change with time but if once good are always good, though changes in the condition of the structure may effect the importance of such details. But there are other ways in which a structure or member, once ample for the work it is called upon to perform, may become dangerously [illegible] of the causes of such deterioration will greatly facilitate the discovery of such weak points at the time of the inspection. In the case of steel and iron, proper protection by paint is the first essential for preservation. It is not enough to paint the parts exposed to view, as if the purpose of the paint were to make the bridge look pretty; it is distressing to see the portion of a highway bridge above the deck glorying in frequent fresh coats of paint, while the dirt from the road pours down on the unpainted surfaces of floorbeams, stringers and lower part of trusses unheeded. Those in charge seem not to realize that if either is to be neglected it should be the part exposed to view, for there the wind also has access to it and will blow away the offending dirt. In painting a bridge, it is far more important that the surface of the metal be properly cleaned than to decide as to relative merits of A, B and C brands of paint. In examining a bridge in the winter a few years ago, a large mud-wasp's nest was found on one pedestal, and all the pedestals were well covered with dirt collected on the bridge seats, the paint having been applied to the nest and dirt instead of to the steel. This example is typical, though worse than is often observed; painters can rarely be induced to clean off rust and scale as it should be done. When paint is put on over rust flake, the new paint skin is soon broken and worse than useless, since the moisture can get under it and has no chance to dry out. It is of prime importance that the steel be thoroughly cleaned before the paint is applied.

It is a common cause of surprise that the older part of a bridge is still in good condition while newer portions are considerably corroded. This condition may be due not to neglect, but to the fact that the original bridge was of iron while renewal parts are of steel. Commercial steel of the present day will not stand neglect at all to compare with commercial iron of a quarter century ago. If properly cared for and protected from corrosion and overstrain, either material would last indefinitely. Cast iron resists corrosion even better than rolled iron and is therefore well suited for pedestals of truss bridges and for rockers of long girder spans, proper precautions being taken against breakage on account of the greater brittleness of cast iron.

[illegible] rusting by excluding moisture from contact with the metal. Too much emphasis cannot be placed on the fact that even the best of paint cannot be thoroughly effective if dirt is allowed to collect on the steel work, since the dirt holds the moisture which will eventually find its way through the paint and do its destructive work with ever increasing speed until attended to. A layer of tar or bituminous mixture has been used effectively to protect the steel in some places. An inexperienced observer may report that the paint on a certain surface is a ¾-in. thick, judging from the difference between the total thickness observed and the original thickness of the metal. This judgment is likely to be wrong, the extra thickness being due to rust, which is three to eight times as thick as the metal which oxydized in producing it. A little experience enables the engineer to judge approximately from the appearance of a rust flake, what thickness of metal it represents. A flake ⅞ in. thick for the whole width of the angle, and several feet in length has been removed from the top flange of a floorbeam though the angle had lost one ⅛ in. in thickness.

As the matter of dirt collection is so important, further discussion of it may not be amiss. When the tops of floorbeams come within a few inches of the under side of the floor dirt will collect, especially in spots where the wind cannot blow through. Trough sections, especially below the floor and without provision for drainage, are also frequent victims of excessive corrosion. Such sections are now commonly avoided, and when used are provided with drainage holes, but these are often so small that they soon become clogged, particularly in the bases of trestle posts and the upper angles of bottom flanges of portal struts so laid that water tends to collect in the upturned angle. In general, ample provision for drainage and for the free sweep of wind are valuable factors in the preservation of steel. Street filth adds much to the destructive nature of dirt accumulation on steel. Dogs are also very destructive.

Effect of Gases and Smoke on Bridge Members.—Locomotive gases and smoke, especially if from sulphurous coal, are very destructive to paint and to the steel which it covers. This trouble is not confined to the time when the smoke is thrown upon the bridge, but has a continuing effect when the soot is dampened by each new shower. This soot has a double action, holding moisture badly and also retaining the sulphur to add its force to that of the moisture. When floor planking is fitted close around truss members or girder webs and stiffeners, the fibers of wood hold moisture against the steel, so that a plate or angle in such position may be entirely rusted through, when at three inches above the top or below the bottom of the planking no corrosion is found. Concrete or asphalt flooring in contact with steel needs a fillet of the concrete or asphalt run up on the side of the metal to assist the drainage away from the steel. Even this is not sure to be satisfactory, as the adhesion of concrete or asphalt to paint is not very good. Recent practice of providing extra thickness of metal at places exposed to locomotive gases and to accumulation of dirt is to be heartily commended.

A blast of cinders from a locomotive is also destructive to the under parts of low bridges over steam tracks, and this trouble is by no means unimportant; yet it is not often as serious as pockets between the stringers and floor beams, which collect and hold smoke sometimes for hours. When bottom flanges of stringers, floorbeams and girders and bottom chords of trusses are encased in concrete to protect them from such injury, the protection is likely to be only transient, even if expanded metal or wire netting is used to tie the concrete together below the steel. Without expanded metal or wire netting, such a thin layer of concrete as is generally put on is more a danger than a safeguard, since it will soon drop off in spots. It is better to spring an arch from the top of the bottom flange of a stringer or beam, leaving the bottom surface exposed; this gives a shape from which smoke will more readily clear away.

Double stringers are frequently placed with flanges close together or with too little space between to allow painting the inner faces or even to let the dirt drop through. Rust is the inevitable result! a single pebble or straw may start the collection of filth which is so disastrous in its effect. Another bad arrangement is that of two members [illegible] separated at the top chord and brought together at the bottom chord; dirt and rust result at the point of contact.

When rust stains are observed they should be [illegible] their source to ascertain the cause. If a reddish discoloration runs down over the painted surface of an eye-bar below the pin, it may be due to a crack in the eye of the bar or in the pin, or to wear of one or the other. If a rust streak shows below a rivet, it may indicate that the rivet is loose or that a plate or angle is cracked. Rust does not develop in such places without some such unfavorable cause. If on a pin it is probable that there is undue movement there, perhaps simply a turning of the pin due to repeated deflection and recovery of the bridge or to chafing of one member against another; either of these tends to wear out the joint, but so slowly that it is far less ominous than a crack. Rust stains where two members come together indicates chafing, whose seriousness can be judged by measurement of the loss of section.

Small rollers at the ends of trusses or of long girder spans are likely to become quickly clogged so that they will not turn. In that case, the truss or girder will usually slide on the top surface of the rollers (which is, perhaps, about as good) and other parts of the rollers will rust so as to preclude all possibility of any future rolling. The prime factor in this prevention of future rolling is not the roughness of the rusted surface but the greatly increased diameter of the rollers due to the greater thickness of the rust as compared with the original metal (as previously described). In short spans the rollers are usually smaller and trouble of this kind is far more frequent, though less serious, than on longer spans. Segmental rollers have sometimes been so small and so poorly constructed that they too become clogged. Frequently small rollers are pulled partly off from the base plate, so that the load is carried on a less length or number of rolls than was intended.

Electrolysis.—Much has been said of the danger of electrolysis and short circuiting on bridges used by electric railways, and it is a real danger, though serious cases are rare. One case observed is worthy of note. A two-span through truss bridge with I-beam stringers 5 ft. on centers and with old chestnut ties 6 in. by 6 in. dapped to 5 in., allowed the current to leak from a poorly-bonded rail to the stringers with the result that in a dozen places holes were burned through the top flanges of the I-beams, or notches burned into their sides. One of these holes had a diameter of 2 in. at the top and 1⅝ in. at the bottom; a stalacite of steel 9½ in. long hung from the edge of the hole. In numerous other places hollows had been burned into the top surface of the stringers, while many track spikes were melted away at the lower end to such an extent that they could readily be pulled out with the fingers. Other spikes had lost their heads and the rail flanges were similar to the stringer flanges. What first attracted attention to these conditions was this appearance of the rail flange and the corresponding charred spots on the ties. In another case, in a through truss swing bridge, both flanges of one channel of the bottom chord were burned off by contact with a trolley pole. The two cases cited are the only serious ones that have come to the author's notice in his thousands of bridge inspections. However, if the steel is found to be charged with electricity, the inspector should make thorough examination to learn the cause of the leak and to discover any damage done where the current enters or leaves the steel work.

Examination of Hangers, Seat Angles, Tension Bars, Etc.—As details of hangers for suspending floorbeams from truss pins are often bad, they must be examined carefully, both in field inspection and in office study. The bend of the loop is examined for cracks; also the upset near the ends or in the threaded part. Nuts may not be turned up so as to distribute the load equally between the two ends of the hanger, or proper stiffness may be lacking in clip angles or in the bottom flange of the floorbeam by which its weight is delivered to the hanger. These are also points subject to accumulation of dirt, hence likely to be rusted, and the strength reduced below that originally intended. Any bending of clip angles or other supports, and any uneven bearing on nuts should be carefully noted. In case there are check nuts (to omit them ever is a serious mistake), it should be observed [illegible] effective.

Stringer seat angles on floorbeams, if not supported by stiffeners, often bend down so that the stringers are really supported by the side connection angles. Serious rust is frequent [illegible]

Tension bars of equal size and length placed in couples or in sets should ring alike (with a note of the same pitch) when struck a sharp blow with a hammer, if the load is equally distributed to them.

Rivets may be tested by striking the head with an inspector's hammer. If a rivet is tight it is efficient for the strains to which it is subjected, even though later increased loads may reveal that the rivet was not properly driven. When it becomes loose it is no longer useful.

In short stringer span (both steel and timber) and less frequently in longer spans, the ends of stringers are sometimes encased in the abutments. This practice cannot be too strongly condemned. If the abutments are of stone masonry and steel stringers are so encased, corrosion will begin immediately; while concrete about steel stringers will sooner or later be broken up by the expansion and contraction of the bridge, exposing the encased steel to conditions in which corrosion will proceed rapidly. Besides, water running down the face of the abutment rusts a groove around the steel. Cases have been observed where more than half the thickness of the web and nearly half the thickness of the flanges of an I-beam have been rusted away by this means, almost as if cut by a cold chisel, the upper surfaces of both flanges being grooved deeper and the under surfaces usually less than the sides of the web. The breaking up of an abutment on account of encasing the stringers proceeds more rapidly the longer the span, and often extends for a considerable distance below the stringers. Timber stringers so encased will decay in a way corresponding to the corrosion of steel just referred to, the capillary action along the grain of the wood adding to the rapidity of the decay. Timber does not break up the abutment as badly as steel does, owing to the slighter adhesion between timber and concrete, as well as to the smaller coefficient of expasion of wood. Timber stringers embedded in earth-fill rot very rapidly; in case such construction is necessary for more than temporary use, the life of the timber may be prolonged by a coating of tar, with an extra thick layer at the ends and at cut fibers or knots in the sides.

Effect of Dampness and Dirt on Timber Structure.—The same influences, dampness and dirt, which cause corrosion of iron and steel are also active in producing decay of timber, and there is the added effect of capillarity, which carries moisture into the interior of timber when the end of the fibers are exposed. So far as corrosion is concerned, a steel beam is sound unless its surface is rusted, but timber may present a sound exterior until its heart is completely rotted away, since rapid drying at the surface may preserve the shell while dampness is destroying the interior. Usually, however, some crack through the sound portion holds moisture between two surfaces and the resulting decay gives surface indication of the condition within. Such a hint should be followed up by the inspector to learn the extent of the decay. If a timber shows damp spots and streaks after a rain, for some time after most of the surface is dry, it may be taken as an indication of trouble within. After repeated soaking and drying permanent dark spots are produced, because the decay has progressed to come so near the surface as to show through. Often the experienced inspector observing timber from a distance recognizes a critical condition, even though a cut a quarter inch may show only sound wood. If timbers are tested by boring with a small bit, the direction of the hole should be such that it will drain. A better method is by driving in a sharp tool like an ice-pick, as the hole so made with reasonable care soon closes up without injury to the timber. Sap-wood is more subject to decay than heart-wood; exposed ends of fibers (whether at the end of the timber or on the side of cross-grained timber) contribute to decay; tops of stringers decay more than the sides and bottom; and timber laid with rings concave side up decays faster than if laid with the convex side of rings up.

Life of Wood.—It is a familiar fact that wood which is kept for some time in a warm dry place may lose what is [illegible] a large part of their bending strength being destroyed though no ordinary decay is shown. If the con- [illegible] breaking a splinter cut from a corner of the timber, the break being directly across the fibers rather than a tearing apart or splintering [illegible] the danger of deterioration while apparently sound that a lower relative unit stress is allowed for these woods than for hard pine. Hard pine, white pine and spruce are much less liable to this form of deterioration; but in the rotting of any timber the loss of strength is of course gradual from that of sound timber to that of tinder or punk.

[illegible] bridge without full knowledge of its condition and of any elements which would reduce its durability; but wooden bridges are often built of timbers that have been cut for several years and [illegible] destructive than will be found in its position in the bridge. A bridge superintendent once expressed surprise at the rapid decay of certain stringers recently put under a track on a bridge. The explanation was that these stringers had been lying in the grass near by for five years, waiting for him to get time to put them in place; and no one knows how long they had been in storage before that.

Creosoting, kyanizing, vulcanizing, etc., are deterrents rather than absolute preventives of decay. They all act by stopping the pores of the wood and thus keeping out the moisture. Creosoting is the most effective of these processes, though for soft woods, as spruce and white pine, kyanizing and vulcanizing are of great value. Hard pine that is full of pitch may resist decay as well as if creosoted, but for protection from teredo and limnoria the poison of the creosote adds to the efficiency. Unfortunately, most of the hard pine now in the market has been cut from trees which have been tapped for turpentine, so that the pores are not filled with pitch.

Wherever two timbers are placed close together dirt and moisture tend to collect and rot results. An important case is where an end (cut across the fibers) is in contact with another timber, as where a trestle post bears against a cap or sill, where ends of stringers butt against each other, or where braces butt against chords in timber trusses. The practice adopted by some engineers of putting iron castings between trestle posts and sills or caps and between trestle caps or wall plates and stringers is to be commended; the same may be said of cast iron spacers between stringers. The ends of timbers may well be smeared with pitch or tar. Even timbers not in contact may be injured by the collection of dirt between two pieces placed too close.

If timber is subject to shearing stress along the grain, as at joints of queen trusses where braces butt against the chords, careful examination to detect the slightest crack is necessary. In such cases, too, exact measurements are needed to determine the bearing areas and the areas resisting sheer as well as the net area of timber left in tension members. If bolts or clamps are used to assist the timber, their exact location and direction must be ascertained for careful consideration in office investigation.

Wood trusses frequently have two or more timbers combined into one chord, with oak keys to distribute the strain among the different members, and where the length of a chord is too great for one stick of timber, different lengths are clamped together with wooden clamps. Often at these keys or clamps there may be very evident signs of overstrain no less reliable than the evidence found by calculating the stresses. Such places should always be examined for such evidence as they may afford.

Bridge men are surprisingly free in cutting into stringers to provide for lateral rods, water pipes or anything else they think they would like to have in the place occupied by the stringers. Stringers have been observed with their depth reduced by such notching to less than half the original. Even some men who understand that such cutting reduces the section modulus, seem not to realize that the bending moment at quarter-span points may be three-fourths as great as at mid-span nor do they appreciate the danger that the timber will split from the top of the notch. Stringers deeply dapped for bearing on floorbeams may have their capacity determined by the sheer along the fibers at the top of the dapping.

Corroded steel sections and decayed wood, or chafed or cut members should be carefully measured to determine the amount of damage, unless the location of the injury makes its amount unimportant. In calipering steel precautions must be taken to remove all the rust scale before the measurement is made, and with decayed wood it should be remembered that the injury has progressed beyond the part which is entirely soft.

Floor.—Full information in regard to the floor should be recorded by the inspector. If the bridge is used by the railway only the kind, size and spacing of ties and guard timbers and the amount of dap should be noted; also the height of main and guard rails, whether well spliced and spiked, distance between main and guard rails, arrangement of ends of guard rails and how far beyond the ends of the bridge they extend. The purposes of guard timbers and guard rails should be kept clearly in mind in order that their efficiency for those purposes may be observed. The primary object of guard timbers is to maintain the spacing of the ties (to prevent bunching) and the secondary object is to stiffen the floor and make the ties work together; the purpose of the guard rails is to prevent the straying of a derailed truck and to bring back near the proper position a truck that may have been derailed on the approach to the bridge. For these purposes, it is important that guard rails should be approximately of the same height as the main rails and that they should be securely spiked and well spliced. The ends of guards rails should be brought together near the center of the track at points not less than fifty feet beyond the ends of the bridge; and it is desirable that the ends be protected by a frog point or other device from injury from fallen brakebeams or chains hanging from the cars. If the grade is steep guard rails should be extended up grade for more than 50 ft. beyond the bridge, and if there are sharp curves on the approaches for which guard rails would be required the bridge guard rails may be merged with those for the curves. The condition of ties and guard timbers should be noted, due regard being paid to the duty of each. If ties are sound under and near the rails, so as to give firm support and good grip for the spikes, decay at the ends and near the middle is of slight importance unless the ties are subject to considerable bending moment.

Sometimes a specially careful but unreasoning bridge man paints ties, expecting thus to make them more durable. The result is usually just the opposite; track men and, sad to say, the public soon wear off the paint from the top of the ties, allowing moisture to enter there, while the paint on the sides and bottom delays the drying; hence the conditions are right for rapid decay. It is of some value to paint the ends (though tar or pitch is better than paint) and it may do some good to paint the top, but the bottom and sides should be left unpainted.

In highway bridges with double plank floors, the lower planking will decay rather quickly unless treated with creosote or other preservative, while the top planking usually fails by wearing out. Unless the traffic is very light it is advisible to use under planking of creosoted hard pine of sufficient thickness to distribute the loads, and top planking of some timber that will stand wear well, like oak or chestnut. On bridges used for very light traffic a top planking of chestnut laid with the heart side up is sometimes found to be curled and warped badly.

Waterproofing Airplane Propellers with Aluminum Leaf.—A waterproof coating for airplane propellers, which incorporates thin aluminum leaf in the finish, was developed by the Forest Products Laboratory at Madison, Wis., and placed in production by the War Department. The process is practically 100 per cent effective in preventing absorption of water, particularly in the storage stage. A French authority states that 80 per cent of the French propellers produced are rejected by the pilots mainly because they are out of balance. This difficulty is due largely to unequal absorption or distribution of moisture and can be greatly reduced by an effective waterproof coating.

Method of Breaking Up Ice Gorges with Dynamite

Damage to the extent of millions of dollars is caused every year in this country by ice gorges. Bridges, docks and other structures along the shore are carried away or destroyed by the sheer force of the ice. Probably the greatest damage, however, results from the flooding of the surrounding country by the water which is dammed up by the ice jamming against bridge piers or other artificial obstructions. Sometimes at narrow parts of the stream where the current is sluggish, the water freezes right to the bottom. When the thaw comes the ice at this point does not thaw quickly enough, so that when the upper ice gives way it rushes down and piles up at the solid section, thus forming a barrier or dam. If action is taken at the right time much of the damage caused by ice gorges can be prevented by the use of dynamite. An interesting description of the various methods of breaking up ice gorges by blasting is given by Mr. S. R. Russell in a recent issue of the DuPont Magazine, to which we are indebted for his matter in this article.

Floods due to ice gorges occur usually about the same time each year in various localities. The gorge also is generally formed at the same place in the river or stream. For this reason, therefore, preparations can be made and work started in ample time before the break actually occurs. When the "back of the cold spell is broken" some time elapses before the ice begins to melt.

It is well to begin at the downstream end, considerably below the probable location of the gorge, and work upstream some distance above it, depending on the width and size of the stream. The ice should be practically honeycombed or cracked up below and above the danger point, so that when the "rush" comes it will give or move easily without jamming or causing damage.

A force of men should be put to work digging holes from 6 to 12 in. in diameter clear through the ice with ice spuds or picks, beginning at the downstream end and several hundred feet below the probable location of the gorge. These holes should be about 30 ft. apart across the stream, and from 60 to 75 ft. between rows. It is advisable to shoot one row at a time at first, then the execution of the charge can be noted and determined whether or not it is advisable to decrease the charge, or space the holes further apart. For the initial charges from five to ten 1¼ in. by 8 in. cartridges of 40 per cent dynamite should be tied into a bundle with a stout cord, and each bundle primed with an electric blasting cap. One bundle of dynamite should be dropped in each hole so that it will be suspended in the water under the ice—even 2 or 3 ft. under the ice is best. A stick of wood laid across the hole on the ice surface to which the other end of the string is attached will prevent the dynamite from being carried away and lost.

The electric blasting cap wires should be connected in series and fired by means of an electric blasting machine. The leading wires running from the holes to the machine should be strung toward the upstream end, and should be sufficiently long so that the operator is at a safe distance from flying ice.

If it is inconvenient to use electric firing, the charges can be exploded by means of fuse and blasting caps; but care should be taken to protect each cap from water by smearing heavy grease or soap at the point where the cap is inserted in the dynamite. Also, a good grade of waterproof fuse should be used. Of course, in the latter method only one hole at a time can be fired, while with the electric method as many as desired can be set off simultaneously with much greater efficiency, assurance and safety. Good safety fuse burns at the rate of about 30 seconds per foot. Do not have a fuse too long, as this means that the fuse and cap are exposed to water a longer time. The bundles can be all made up and tied to cross sticks and about 2 of 3 ft. of fuse used in each. Fuses can be lighted before bundles are dropped in the holes. One minute is ample time for all to get away to a safe distance before the charge explodes.

The size of the charge per hole will depend entirely upon the thickness of the ice. If 2 or 3 ft. thick, about six 1¼ in. by 8 in. cartridges, or 3 lbs. should be used in each hole. If thicker than this, from 8 to 10 cartridges or more should be

The Start of an Ice Gorge—Floating Ice Beginning to Jam on Bridge Piers.

[illegible]

[illegible]

Spudding Hole in Ice.

two or three heavy charges at different points if the gorge is a large one.

If it is impossible to get through the thick ice to the water by ice spuds, a hole can be dug partially through and a small charge of say 8 to 10 cartridges fired in it. This charge will enlarge the hole and probably break through and permit placing the heavier charge in the water under the ice. If the first light charge does not break through or make a large enough cavity, try a second or a third charge if necessary.

The size of the heavy charge will depend, of course, on the thickness and extent of the ice mass, and may vary from 50 to 100 lb. up to a ton or more. Size of charge must be regulated also according to the location and proximity of structures that might possibly be damaged by the explosion. It [illegible] to blast too heavy [illegible] too near a bridge pier, a cable line, dock or a factory building on shore. If, however, nothing like these interfere it is well to use larger sized charges. The tendency of most people in using dynamite for blasting ice is not to use enough. The reason is that the work is usually performed by those who have very little knowledge and a very exaggerated idea of the force of high explosives.

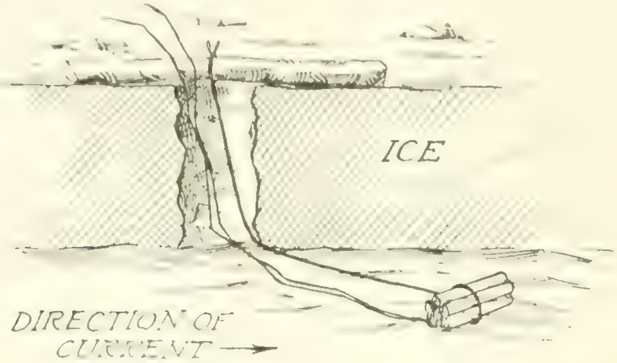
Charge Placed to Enlarge Hole.

In breaking the great ice gorge at Niagara several years [illegible] lb. [illegible] were used at one time, distributed in three charges, before the ice gave away.

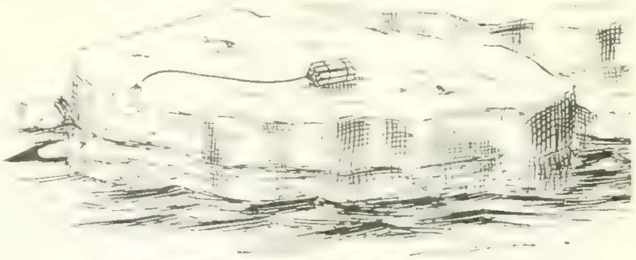
It is well in blasting ice to err on the side of over-charging, as this sort of blasting can usually be carried on without fear [illegible] of nearby property.

When heavy charges are necessary dynamite can be placed in position in its original cases, containing 50 lb. each.

If the ice is floating, a gorge can often be prevented from forming at some lower point in the stream by shattering and breaking up the large floating cakes before they reach the narrow part or obstruction. Breaking these large floating cakes is best accomplished by throwing charges of dynamite onto the cakes from the shore; or, if possible, from the downstream side of bridges considerably above the danger point. Each charge should be primed with a blasting cap and fuse, and a charge may vary from two cartridges to eight or ten cartridges of 40% dynamite tied securely into a bundle with a cord. The bundle can be wrapped in old newspaper or gunny sacking, which makes it less liable to roll or slide off the ice. In blasting ice in this way it is necessary to light the fuse while the dynamite is in the hands of the blaster, and particular attention should be given to having the fuse plenty long enough, and the charge must be thrown just as soon as the fuse is lighted.



Charge Tied to Stick Laid Across Hole in Ice.



Charge Placed on Floating Ice Cake.

It is most essential to make sure that the dynamite is thoroughly thawed before using, as chilled or frozen dynmite will not give satisfactory results. For that reason, low freezing dynamites are recommended for this class of work.

Do not leave dynamite exposed too long to cold water. Get all holes dug and bundles made up before loading, and place and fire the charges as quickly as possible.

New Type of Window for Farm Buildings.—A standard puttyless, skylight construction window, designed especially for barns, hog houses, etc., has been brought out recently by the Milwaukee Corrugating Co., Milwaukee, Wis. The glass is held firmly in place by copper clips, which make the glass easily removed and replaced. The 4-in. flashing all around the window prevents leakage and the center gutter in the frame carries off any rain or condensation of moisture from the glass. The glass is protected by a ⅜-in. diamond mesh metal covering, which prevents breakage from hail storm or other causes. Provision is made in frame for two panes of glass 10x28 and the frames themselves are made "double" with 12-in. space between, wherever desired.

The Engineering Pamphlet

By R. FLEMING,
American Bridge Co., New York City.

What is a pamphlet? Johnson's dictionary [illegible] "A small book, properly a book sold unbound, and only stitched." This definition is practically retained in Worcester's dictionary of a hundred years later as well as in the latest "Standard." Webster adds, "Commonly with a paper cover." Stormonth's dictionary defines it, "A small book of a few pages merely stitched together, and relating to a topic of ephemeral interest." The "Century" dictionary gives one column and Murray's "New English Dictionary on Historical Principles" two columns to the word.

Spofford, for so long the librarian of Congress, calls attention to the fact that great and influential publications have appeared in the world in the guise of pamphlets. He cites Milton's "Areopagitica, or Plea for Unlicenced Printing," Webster's speech for the Union in reply to Hayne, Charles Sumner's "The True Grandeur of Nations," all of which were first printed as pamphlets.

Engineering literature also has its noteworthy pamphlets. One is that by Whipple, entitled "An Essay on Bridge Building containing Analyses and Comparisons of the Principal Plans in Use, with Investigations as to the Best Plans and Proportions, and the Relative Merits of Wood and Iron for Bridges." This pamphlet of 47 printed pages was published early in 1847. The 50 or 60 copies which the author circulated among engineers met with so cordial a reception that he suspended distribution and wrote a second "Essay" which he added to the first and published as "A Work on Bridge Building." This book is recognized as the pioneer of its kind. But let it be remembered that the pamphlet preceded the book and that a correct analysis of the stresses in a bridge truss was first published in a pamphlet.

The Government Printing Office issued in 1894 a "Report of Board of Engineers as to Maximum Span Practicable for Suspension Briuges"—a paper-covered volume of 109 printed pages. (Perhaps it should be called a book rather than a pamphlet.) It is said that the issue was limited to 500 copies. What makes this Report especially value is "Appendix C. Wind Pressures. Compiled and prepared for the Board by Capt. [now General] W. H. Bixby, Corps of Engineers." This monograph on Wind Pressure was pronounced at the time the most complete and reliable treatise upon the subject that had been written. Fortunately it was kept from being buried by being reprinted in full (Engineering News, March 14, 1895). In this same Report are "Appendix D. Temperature Strains in Three-Hinged Arches. By Gustave Lindenthal C.E. and "Appendix E. The Theory of the Stiffening Girder. By J. Melan. . . . Translated by permission."

What shall be done with the pamphlet? Engineering pamphlets should certainly be kept in some way. They are usually of more than "ephemeral interest." What structural engineer is not interested in the following titles?

"Web Stresses in Plate Girders," Professor W. E. Lilly.

"A Method of Measuring the Stresses at Any Point on a Structure, Due to Wind Blowing Against that Structure," Francis E. Nipher.

"The Strength of Brick Walls to Resist Wind Pressure," Wilfrid Airy.

"The Effect of Stress on the Corrosion of Metals," Thomas Andrews.

"The Economic Design of Columns," Professor W. E. Lilly.

"Columns," O. H. Basquin.

"Modern Illumination in the Iron and Steel Industry," C. E. Clewell.

"The Arrangement and Construction of a Modern Manufacturing Plant," Thomas Flinn.

"Economy in Rectangular Panels, Using Beams of Constant Cross-Section," J. S. Branne.

"Printed Engineering Resources," J. Martin Telleen.

Titles of equal interest might be selected from other branches of engineering. Spofford thinks that multitudes of pamphlets are annually lost to the world from the want of any preserving hand to gather them and deposit them permanently in some library. It is true that papers like those mentioned are often embodied in the transactions of some society and thus do not become totally lost.

The librarian has his own problems with the pamphlet. Where is the dividing line between a pamphlet and a book? The British Museum draws it at 100 pages. Shall pamphlets be put on the shelves as separate publications as is done by the American Society of Civil Engineers or shall they be classified and loosely bound together in "pamphlet volumes" as is done by the New York Public Library? These, however, are questions for the librarian to settle. A more important question is, how shall the existence of a pamphlet be made known to those who would be interested in it? Engineering research is often duplicated for lack of a clearing house that will supply information as to what has been done along particular lines. The pamphlet literature on the subject is not known. How shall this literature be made available?

New Process for Creosoting Fir Lumber

A new method of creosoting Douglas fir timber, developed by Prof. Bror L. Grondal of the College of Forestry of the University of Washington, is described in a recent issue of the West Coast Lumberman. The new process is designed for the creosoting of air seasoned material only, and promises to save a considerable amount of material that is rejected under standard specifications when treated by the methods ordinarily employed in the treatment of this class of material. The new process consists in the elimination of initial heat treatment and immediately subjecting the piling or lumber to "cold" creosote under long continued high pressure. Experiments made by Professor Grondal in the experimental plant of the College of Forestry, which has been duplicated at one commercial creosoting plant, have given very favorable results, and a number of tests in commercial plants are contemplated. The new process is based on the hypothesis that the preliminary heat treatment in the old method has the effect of causing the moisture in the wood to come to the surface, as air seasoned material in the larger sizes of timbers usually contains from 20 to 30 per cent of moisture. If this preliminary treatment is continued for a sufficient length of time the wood becomes dry and readily admits the creosote under pressure. When continued for only 12 or 15 hours there is very little drying effect, as wood is a very poor conductor of heat, and when the creosote is applied under pressure it must move in a direction opposed to the travel of the escaping moisture. In the new method, omitting the preliminary heat treatment, the creosote, which is slightly miscible with water, penetrates the wood in a uniform manner, though longer time is required, probably due to the greater viscosity of the creosote at the lower temperature. The "cold" creosote is introduced into the retort at a temperature about 115° F., and is allowed to cool to 10° F. As there is no drying action upon the wood, checks which already exist are not increased, as when at a normal temperature Douglas fir has high compressive strength and will withstand high hydraulic pressures. Hot, moist Douglas fir is, however, relatively plastic, and deteriorates under high pressure. Pitch seams are not opened up in the new method, as the cold creosote has only a solvent effect upon the resin in pitch seams, the resin being replaced with creosote. No restrictions are placed upon the use of the new method.

Exhibit of American Timber in England.—The first exhibit of American timber in England has just been held under the auspices of the Royal Institute of British Architects, as a step in the British reconstruction program. Housing forms a large part of the British reconstruction plan, and many other enterprises are projected in which timber and building materials will be required to a large extent. The exhibit was prepared through the assistance of the American trade commissioner, J. W. Walker.

$1,000,000 for Home Building Project at Niles, Mich.—Horace and Thomas Dodge, Detroit automobile manufacturers, have offered $1,000,000 in a home building project to Niles. The City Council will appoint a municipal agent to direct expenditure of the Dodge million. The plan is to loan money on private housebuilding contracts to the extent of two-thirds of the cost of each house.

Architects' Responsibility for Contracts and Bonds*

[illegible]

[illegible] the ordinary [illegible] con- [illegible] His employ- [illegible] contract [illegible] damages to the owner because he makes public the fact of the proposed [illegible] of his employment, he is [illegible] agent of the owner. After the contract has been let, the architect occupies the dual capacity of agent of the owner, and an umpire. It is his duty to the owner, as his agent, to represent [illegible] further. It is [illegible] both the owner and the contractor impartially, and to give his decision on any matter without prejudice.

An architect who procures more from the contractor for the owner than the building contract requires, or who does not exact from the contractor what he reasonably is entitled [illegible] of a breach of his duty, and commits as well a breach of ethics of his profession.

The architect is ordinarily under the original building contract made the arbiter as to the quality and quantity of the work, and must act fairly and should not withhold stipulated certificates due the contractor arbitrarily or upon caprice, or upon any objection based upon his own mistake in formulating plans and specifications.

Architects, in some instances, are representatives of concerns handling certain kinds of materials or equipment which are specified to be used in the building which they are employed in constructing. The law does not prohibit this and in fact does not in any manner condemn it as long as the owner has full knowledge that such is the case. I will not discuss this in the light of the ethics of your profession.

When an architect undertakes to draw the plans for a building, he impliedly represents to the owner that he possesses reasonable skill and knowledge in the things he is required to know, and it is his duty to exercise reasonable care and diligence in the performance of the services he undertakes to perform. The rule applicable generally to members of learned professions, such as doctors and lawyers, is equally applicable to the architect.

Preparation of Bonds and Contract by Architect.—When once the work of preparing the plans and specifications is completed and the bid for the work has been accepted, architects in recent years have, in a great many instances, undertaken to prepare the contract and bonds on behalf of the owner. While some attorneys have complained that this is an entrenchment upon their functions, I have no quarrel with the architects for doing this work. Very often the details of a building contract are such that its preparation is more of a tedious duty than a pleasant task. I have had the pleasure to represent the contractor in passing on the contract for buildings both large and small in a number of instances. The only complaint that I have to make is that the architect, in preparing the contract, very often does his work too well. As he has been employed by the owner and is drawing his compensation from that source, he often considers that it is his duty to drive a pretty fair bargain. In such instances, the contractor, if he is represented by an attorney who is zealous in his client's behalf, has a difficulty in procuring reasonable changes in the contract, which the architect readily assents to. The reason for this is that the owner has read the contract as originally prepared and finds that it securely entrenches him, and does not wish to see some hard and fast provision that might work an injustice on the contractor removed from the instrument. In this regard, I am happy to say that I have had the pleasure to read some contracts prepared by architects which any attorney might take as an example for his future guidance, and which have been more fairly, accurately and completely prepared than 75 per cent of the contracts prepared by at- [illegible]

When the architect undertakes to draw up the building contract, he impliedly agrees with the owner that he possesses reasonable skill in drafting the instrument, and that his skill in such matters is equal to that possessed by those in the legal profession.

If the architects undertake to prepare the bond, the duty placed upon them by law is equal to that placed upon an attorney. If the architect fails in this legal duty, he is liable to the owner and under ordinary circumstances he cannot recover from the owner for the preparation of the same, if they are not properly drawn. This applies equally well to the preparation of plans and specifications. In this regard the burden of proving the inadequacy rests upon the owner.

California Laws Regarding Bonds and Contracts.—This brings us to a discussion of the contract and bonds. No detailed explanation of these matters would seem to be necessary in view of the experience that you have all had in this regard. However, there are a few general ideas which cannot be too often reviewed.

The law as amended in 1911 and as approved by the Supreme Court, requires that the contract, and this includes plans and specifications, shall be filed in the office of the County Recorder of the county wherein the land upon which the building to be erected is situated with a bond of the contractor with good and sufficient sureties in favor of the materialmen and laborers before the work is commenced, if the owner is to be protected against liens.

The contract is now somewhat simpler than it was before the amendment of 1911. It matters not in what way the contractor is to get his compensation. It may be in real estate, personal property or anything of value. There is no longer any requirement of law that any proportion of the contract price shall be retained by the owner after the completion of the building, although I consider such provision in the contract a wise precaution.

The form of the bond which should be used is easily procured. This bond should be signed, not only by the contractor, but by two good and sufficient sureties. The law in this regard is in the plural.

It is surprising how many invalid bonds have been taken in the belief that owners were being protected. I, personally, tried a case in Imperial Valley a few months ago in which the liabilities were only a few thousand dollars and the bondswoman was worth several hundred thousand dollars. Judgment for a lien in full was given and quite properly, although the balance due the contractor was found to be much less than the amount of the liens.

The provisions of law in this regard must be strictly adhered to, and it is the duty of the architect not only to procure two sureties, if he undertakes to prepare the bond, but it is also his duty to have an investigation of the worth of said sureties made. If he accepts straw bondsmen, where he undertakes to accept the duty of passing on the bond without making an investigation, even though he does do so in good faith, and the owner is thereby damaged, I believe that the courts would hold him financially responsible for the loss suffered thereby.

As a suggestion to the architects, I would advise them to have the owner investigate and express his own satisfaction with the sureties before the bond is accepted.

There is no enactment requiring any bond from the contractor to the owner to be taken. This, however, is a very wise precaution, and its amount may be varied to suit the particular necessity of the case, but usually a 25 per cent common law bond is sufficient for all purposes. I have known of instances, however, where I have insisted that the contractor should give a 100 per cent bond to the owner, for I felt that he did not intend to pay any of his bills and was really not worthy of having the job.

What I have said with regard to two sureties applies only to individual bondsmen. Our law provides that a corporate surety authorized to do business in the state is sufficient in such cases.

The law with relation to the construction of public buildings seems to be well established, but not very well understood by architects, attorneys or the courts. I do not know the reason for this, but base my assertion upon personal experience.

I wish to caution you against using the usual form of 50 per cent bond to materialmen on public jobs. While I think this bond can be sustained, yet it is a source of trouble if the job does not work out properly. I have a case involving such question now on the way to the Supreme Court.

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*[illegible] Southern California Chapter of the [illegible]

The bond on public buildings is required by the statutes of 1897 as amended in 1911. This is not the mechanics' lien statute, but is a provision of the general laws. It requires that the contractor and his sureties must file a bond to laborers and materialmen in the sum of 50 per cent of the contract price, before commencing work. This is the only protection that the laborers and materialmen have, and it is the duty of the architect, if he undertakes to prepare such bond, to see that the materialmen are protected.

With relation to the common law bond to the owner, it is my suggestion to you that if there is any material change in the plans or specifications or the construction of the building, that the sureties on such bond should be notified, and their consent procured. This will often obviate a technical defense in case the contractor falls down on the job.

There seems to be a general misunderstanding as to when a notice of completion should be filed. This notice must be filed within 10 days after the actual completion of the work, and without reference to the time of the acceptance by the architect or the owner, and without regard to the issuance of the architect's completion certificate. It is the fact of the completion, and not the architect's certificate which controls.

I have known in connection with some of the largest buildings in this city, that the notices of completion have been filed not within 10 days after the actual acceptance by the owner, but more than 30 days after the actual completion. This affords the owner no protection that liens will not be filed after 30 days after the filing of the notice of completion. In such cases the materialmen have 90 days from the date of the actual completion, as the owner forfeits his right to cut off the running the lien time by his failure to file within 10 days after the actual completion. The courts will not accept the architect's certificate as any evidence of the date of the completion of the building.

Another duty which is often imposed upon the architect is that of being arbiter in a dispute between the contractor and the owner. In this regard he must act with absolute fairness, or the courts will set aside his decision. If he has given his decision fairly, it concludes the matter. The clause in the contract providing for arbitration is one which works entirely to the benefit of the owner. The contractor cannot go into court on a matter which the contract provides must be settled by arbitration without first having offered to arbitrate the matter. If he offers, and the owner refuses, the courts are powerless to enforce the provision for arbitration, and the only thing the contractor can do is to bring a suit at law.

Connecticut Engineers Ask Appointment of State Committee on Reconstruction.—The Connecticut Society of Civil Engineers at its annual meeting, Feb. 18, passed a resolution, asking Governor Holcomb to appoint a committee on the reconstruction of public works. The resolution reads as follows:

"Whereas, Since the signing of the armistice there has been a great reduction in the amount of work being done throughout the country and a consequent lessening in demand for workers of all grades, while at the same time the officers and men returning from our armed forces expect, and are entitled to receive, employment at least as congenial and remunerative as the positions they left to enter the service of the country; and

"Whereas, There is a large amount of public and private work which has been delayed during the last three years and which might properly and economically be undertaken in the not distant future; and

"Whereas, If present conditions are long continued, serious results may be brought about; therefore, be it

"Resolved, That a committee be appointed to ask Governor Holcomb to consider the question of urging the construction of public and private works and other activities during the period of reconstruction and the appointment of a commission to further this movement."

The Deactivator System for Elimination of Corrosion in Hot Water Supply Pipes

In our issue of Sept. 25, 1918, we described the deactivator system of eliminating corrosion in hot water supply pipes. Under this system, by keeping hot water under pressure in contact with a large surface of iron, it is possible to remove and "fix" the oxygen, thus rendering the water practically non-corrosive. This method has been adapted to practical use in three plants—one at the Hemenway Terrace building in Boston, one at the Research Laboratory of the National Tube Co., and the third at the Irene Kaufmann Settlement at Pittsburgh. The matter in our Sept. 25 article was based on a paper by Mr. F. N. Speller, metallurgical engineer of the National Tube Co., presented before the American Society of Heating and Ventilating Engineers. At the January, 1919, meeting of the society, he contributed a further discussion which brings up to date the matter of deactividation of hot water by the above process. In his discussion Mr. Speller stated that no trouble had been experienced with their the plant of the Kaufmann settlement or the plant installed in Boston. The plans at the Irene Kaufmann Settlement, Pittsburgh, has now been in use continuously for over three years and neither of these apparatuses have been opened for renewal of the steel plates of filter material. After this period the analyses of the water shows the same percentage of oxygen removal as was found when these plants were installed.

The new test pipe put into the Irene Kaufmann Settlement installation two years ago, using deoxidized water, were reexamined and the following report of the Pittsburgh Testing Laboratory describes the results to date:

"The pipes included in this test were originally two 29 in. lengths each of 2 in. uncoated black steel pipe and 2 in. wrought iron uncoated black pipe.

The installation was made Nov. 22, 1916, on which date it was first put into service. On Dec. 24, 1917, the pipe line was reopened, and the wrought iron pipe and steel pipe found to be practically uncorroded after more than one year of service. Their inner surfaces were covered with a soft, black slime. Oxygen removal by the deoxidizer had at times been incomplete, because of the low temperature of the water. Nevertheless, corrosion had caused during this time, perforation of duplicate pipes in part of the same hot water system unprotected by the deoxidizer."

"Samples of the zinc and brass which had been in the line for 42 days showed practicaly no corrosion, while similar samples in the unprotected part of the hot water line showed pitting of the zinc and solution of the zinc constituent of the brass, leaving metallic copper at the edges of the brass samples. The zinc and brass specimens were put back into the line, and riveted couples of steel and copper sheets, and of steel and brass sheets, were also placed in the line. Copper rivets were used.

"On Jan. 3, 1919, after two years and 42 days of service, the condition of the pipes in the deactivated hot water line was again observed, and found to be so good that it was decided to continue the test for at least another year.

"The pipes showed the same soft black coating, and there was no evidence of pitting, even where the steel pipe was in contact with a brass union, a condition favorable to rapid corrosion by electrolytic action.

"The specimens of zinc, brass, etc., already mentioned, were removed, and sent to the laboratory in order to determine their losses in weight and general condition. The relative losses of weight were very striking. The zinc plate had lost in the deactivated water, in about 12 months, only 1 per cent, as compared with 10 per cent in the untreated water in the same line.

"The brass plate, during the same period, lost less than 0.1 per cent in the deactivated water, as compared with more than 1 per cent in the untreated portion of the water in the line.

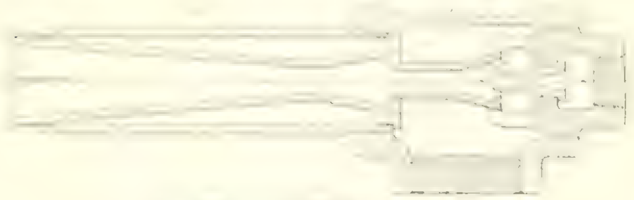
"The steel in the riveted brass and steel couple lost about 16 per cent in the deactivated water, but was entirely corroded away in the untreated water in the same line.

"In the case of the riveted steel and copper plates, the loss

[illegible]

Air Syphon Blowers for Rivet Furnaces

[illegible] mixed with the initial air and delivered to the furnace with [illegible]



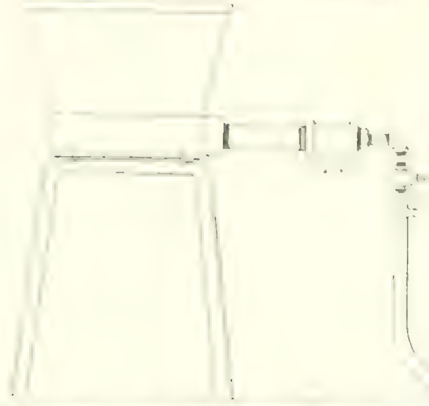


Fig. 1—Two-Stage Rivet Furnace Blower.
Fig. 2—Application of Blower to Rivet Furnace.

[illegible] the high pressure supply to 25 per cent of the total, utilizing 75 per cent of free air in the furnace.

The percentage of induced free air taken in under fixed conditions depends entirely on the more or less correct design of the syphon blower, and runs from 30 per cent in some of the crude arrangement to 75 per cent or 80 per cent for the best standard makes of syphons. The higher efficiencies are obtained by multiple nozzle arrangements, in which a very small high pressure air jet (less than ⅛ in. in diameter for an ordinary rivet heater syphon) discharges through an injector tube drawing in a small quantity of free air. The first injector tube discharges into a second one forming a second syphonic action, etc., which is carried on through successive stages where high pressures are to be reduced to relatively low ones.

The accompanying illustration (Fig. 1) from the Standard Practice Bulletin of the Division of Steel Ship Construction of the U. S. Shipping Board, shows a simplified design of a 2-stage rivet furnace blower.

In this design a standard 1¼ in. screwed pattern, cast iron tee is used for the body of the instrument. The self-contained cast brass nozzle arrangement is screwed into one end of the tee and provided with threaded connection for high pressure pipe, while the delivery tube connecting the body to the furnace is screwed into the other end. In order to give rugged construction and further economize in production, a short piece of standard pipe is used for the delivery tube and the correct syphonic proportions are obtained by the insertion of a non-corrosive lining. It is stated that if the nozzles are properly proportioned blowers of this design will give thoroughly good results.

Consolidating the American Engineering Professions*

By A. D. FLINN,

Secretary, Engineering Council.

The organization of engineers in America is chaotic, complex and illogical. As consequences there are confusion, waste, inefficiency, and dissatisfaction, which, however, are exaggerated in some minds. If no associations existed, it would be relatively easy to plan and create a system of organization that would satisfy demands much more effectively than does the present multiplicity of unrelated societies. But there have grown with the years traditions, and loyalties, and prejudices, clustering about the societies that now are. An answer to the problem thus created is not easy. To me the solution is not obvious, but some progress in the process is now appearing. There must be extensive consolidations, more federation, and much simplification, each of which demand elimination. Steps are being taken, or preparations made for them, in various ways and places, and by a number of agencies. They will be accelerated as their benefits gain appreciation; but education, time, and patience are needed for attaining the goal.

The Problems Confronting a Consolidation Scheme.—What are the present desirable limits to consolidation and federation? To what goal should they tend? By what methods and means can they best be brought about? These and similar questions are not being answered conclusively, because the necessary facts are not in hand. We have been muddling along in an unengineering fashion, attempting to plan and design and specify without a survey. On Sept. 12, Engineering Foundation by formal vote proposed to make the much-needed survey and preliminary studies, the four Founder Societies concurring. Of the necessity for this survey I have been more deeply convinced with the passing weeks, as I have listened to ineffective arguments and to misstatements based on ignorance which can be corrected only by the results of the proposed survey of engineering organizations.

Without the enlightenment of such a survey it now seems that the following elements of organization are desirable for the engineering profession in America: Excepting possibly three or four cities having large numbers of engineers, there should be in each community, having a sufficient group of technical men to be organized, one organization that embraces them all. Reasons for this are obvious. This organization may be an association of local societies and sections of national societies, or it may be a society admitting to its membership men of all branches of the profession. Examples of both forms of organization exist in a number of places. Local organizations should have large measures of autonomy, but should conform to approved types and standards.

Logically, the next step in organizing would be the combining of these local organizations into one or a few national societies, so that the loyalty, interest, comradeship, and activities naturally developed by the local organizations would flow to the national societies. But at this step the difficulties increase. Many engineers cannot become active members of local organizations, because of distances from headquarters; others do not desire local membership. If there were only one national society, many of the difficulties of scheming a system of organization would disappear; but there are, and probably for some years will be, several national societies of importance, and in each local organization there will be members of two or more national societies. A number of plans have been submitted to me for overcoming these difficulties. None is wholly acceptable. These problems lie at the bottom of the tasks of the committee on development, of the American Society of Civil Engineers, and of the committee on aims and organization, of the American Society of Mechanical Engineers, and similar committees which may be appointed by other societies. Many engineers are giving them earnest thought.

There are said to be approximately 400 organizations of engineers in America, of various kinds. Of these, about one-quarter are the leading national societies and their local sections. In general, the remaining societies have no official relationship, excepting the associations of local societies and sections in a few communities. Consequently the engineering profession, before the public and Government, has no one organization which represents it as a whole, as have the medical profession, the lawyers, the chemists, the architects, the Chamber of Commerce and even labor. In the memberships of the Founder Societies, aggregating 35,000 engineers, there have been variously estimated to be only one-third to one-sixth of the total number of engineers in the country. The engineering profession lacks solidarity.

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*From the Engineering and Mining Journal.

Engineers Have Exceptional Facilities.—Not a little of the dissatisfaction voiced in various quarters as to the shortcomings of the national societies grows out of ignorance or lack of apprehension of benefits actually received. In no small measure the complainants are at fault in not making better use of the facilities provided and the means of information put within their reach. Furthermore, some important benefits of membership in large technical societies are intangible and not capable of definition; not a few persons overlook these. Nevertheless, there are causes for reasonable dissatisfaction. The societies are endeavoring to remove these as they are recognized and remedies can be found. Humanity and its institutions will never be wholly rid of dissatisfaction, and to this truism engineers are no exception.

In this connection, a quotation from the presidential address of Charles T. Main to the American Society of Mechanical Engineers, December, 1918, is interesting reading:

> In the Monthly Bulletin of the American Institute of Mining Engineers, March, 1918, there appeared the following:
>
> The vision dwells in the minds of many that ultimately these four great societies, lightening the emphasis they place upon their differences, may see the time when for the solidarity of the profession, for their best interests, as well as for the increase of their influence on the country at large, they may become one great national association of engineers. With the gain in power and prestige inevitably following such an aggregation, freedom for individual development may be achieved through divisions along the lines of technical interests, which might either follow the present four grand divisions or be more minutely subdivided.
>
> An organization of this sort could and probably would be more strictly professional than any of the four have been heretofore, and through the prestige and power of its numbers could establish standards of ethical conduct for its members, violation of which would bring grave consequences.
>
> This great vision is worthy of the most careful consideration and might be carried with safety to a point where the national societies would be gathered in under one executive head, without any one losing any vital portion of its individuality.
>
> should go for some time to come.

Whatever scheme of organization be ultimately selected, it must be flexible, so as to meet successfully constantly changing conditions, and it must provide for both technical and social requirements of the membership, while maintaining high standards. "Social requirements" is here used to mean, in addition to social intercourse among members, services of the organizations to Government and to the public, and services to engineers individually, such as assistance in securing engagements and better standing in corporate and governmental employment. Technical and social functions probably will be best kept distinct. Some engineers even suggest separate organizations; but at present prefer separate departments of one organization or of a federated group of organizations.

The United Engineering Society.—So far as known, none of the leading organizations has stated a definite policy on these questions. Opinions herein expressed are only personal. The statements in this paper are merely a contribution to the general discussion of this subject by one who for several months has had especial opportunities for learning the opinions of others and gathering a little information.

As regards the joint activities of the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, the present organization seems involved; and even some members of the governing bodies of these societies have difficulty in keeping relationships straight. It is, however, not so complex as some persons assume. It may be simply stated as follows: The four Founder Societies named have joined in creating the United Engineering Society to hold and administer property and to perform other broad functions for them. At their request the United Engineering Society has established three departments, the Library Board, the Engineering Foundation, and Engineering Council.

The Engineering Societies Library has possibilities for active usefulness to the engineering profession and to the industries of this country. Its present passive services are good and of great value, but the library can do much more. Funds are needed at once for complete re-cataloguing of the books, for strengthening the collection of books, and for instituting new lines of service. The books of the societies have been brought together, but they have not yet been assembled as one library. Never, except during the war, has it been so important that all useful recorded technical information should be fully and quickly accessible to engineers—not only to those in the New York district, but also to those scattered throughout the whole land.

The Engineering Foundation now has an endowment of $300,000, yielding an annual income of $15,000. It rendered vital financial assistance to the National Research Council at the latter's inception in 1916, and for the year terminating in September, 1917. That council performed services of great importance to the Government during the war. For the future it already has in hand many projects. One of the most important of these is the promotion of industrial research, in which the Engineering Foundation is co-operating. The Engineering Foundation investigated a scheme for spray camouflage of ships; is conducting long-time tests on the wear of gears, and is making a research on the selective control of wireless communication. It has offered to undertake a "survey of existing engineering organizations, and from information thus developed to formulate a series of constructive recommendations which may be serviceable in guiding the further development of local and national engineering organizations, in their relations to the profession of engineers, to the public, and to one another." Other projects are being studied, but cannot yet be announced. Engineering Foundation's policy is to devote its energies and resources to undertakings of broad application, such as bringing about and stimulating co-operation among existing agencies engaged in research and outlining programs and organizations for research in specific fields.

The Engineering Council, since its organization meeting on June 27, 1917, has made progress in exploring its proper field of activity and fixing some of its boundaries. It has accomplished much useful but negative work. In other words, it rejections have been important and have consumed much time. But there are noteworthy constructive achievements, also, on the credit side of its records. During hostilities the Council rendered no small aid to the Government through the American Engineering Service, which procured thousands of engineers for the War, Navy and other departments, and through the War Committee of Technical Societies, which assisted the Naval Consulting Board and the Army General Staff in examining scores of thousands of suggestions for naval and military devices. Through efforts of its public affairs committee, the Council aided in having the military draft adjusted to permit the continuance of training in the engineering schools of the vitally necessary technical men. Through the industrial affairs committee vigorous opposition was offered to "anti-efficiency legislation" in Congress. Ten days after the signing of the armistice, the Engineering Societies Employment Bureau, with the four Founder secretaries as its board of directors, was substituted for the war-time American Engineering Service. The fuel conservation committee acted in a consulting capacity to the Fuel Administration and the Bureau of Mines in securing war economies, and is continuing its much-needed services into the era of peace. The water-conservation committee is prepared to promote right, and to oppose wrong, national or state governmental actions relating to water-power or other utilization of water, by supplying statements of facts rather than joining in controversial support or opposition of any particular measure. The license committee, with members judiciously distributed throughout the country, is collecting information on the licensing of engineers by the various states, and is prepar-

[illegible] respondents have been selected for direct communication between Engineering Council and engineers at distances from headquarters. Furthermore, important projects of interest to all engineers are in preparation and may soon be announced. One of these is the formation of a national [illegible] capital

[illegible] of one to another, but by all to the community, the state, and the nation. Such public service by engineers, architects, chemists, scientists, doctors, lawyers, and clerymen is our professional obligation, the noblesse oblige of a free and democratic people. Each profession has its distinct service [illegible] men, each must contribute according to that which he has. Service is the only true stepping-stone to that eminence which alone is worth attaining. Greater opportunities have never opened to American engineers than those which confront them in these rapidly passing years of war and "reconstruction."

The Engineer and Labor*

[illegible] the world that means more to it than the conflict of labor and capital. It has always been my hope that the engineer would be the man to correctly solve that and successfully bridge the chasm between the two. There isn't a man who should understand labor better than the engineer, because labor is merely one of the tools that he uses to carry out his ideas. It is just as necessary to him as his slide rule. His plans and his hopes and his promises could not be accomplished unless he employed labor. No trained educated professional man comes closer to labor than the engineer. He certainly should understand labor better than any other man. I regret to say that apparently he does not. I will just tell you a little incident to show you how it has struck me and been borne in upon me.

While Chief Engineer of the Chicago & Northwestern Ry. Co. my two boys during their college education wanted to work right near where we were living. We were building a bridge on our main line involving rather difficult questions of foundations; and so I got them a job with the contractor. They wheeled sand and cement and broken stone, got down in the cofferdam and dug mud, and every other thing. And as soon as the workmen on the job got onto the fact that they were the sons of the Chief Engineer of the road they had their doubts about the sanity of the Chief Engineer for not getting his sons a better job. But nevertheless I had the pleasure every night, when I returned home, of discussing with those two boys what had happened during the day and how things went with them. And they quickly found a new view of life, a new estimate of their fellowmen. Now, these men, as soon as they found they were college boys, would come around and ask them questions about the events of the day, things that they had read in the newspaper and what they thought of it; asking for explanations of things that they didn't understand. So that I felt those two boys got a training that no college, no educational institution could give them; something that I hope will be of benefit to them for the rest of their lives in correctly estimating their fellowmen.

Now, engineers, in all the work that you handle, all the men that you direct, you should get closer to them, you should know their hopes and their aspirations and their de[illegible] because they are making up this country just the same as you are. I have never in my experience as an engineer in directing work, whether it was in the pneumatic caisson with the Father of Waters rolling over the top of us and with the body of the sand hog glistening while we were lowering the caisson, or anywhere else, failed to find that the human touch meant more than anything else. It is what we lack in our daily recreation with the men that we work with; the human touch and the human feeling. It's the thing that is going to be necessary in this new condition that is coming over society. It is coming. We have got to have a better understanding with each other, a better understanding of each other and of our fellowman, whoever he may be. As long as he is associated with us, is a part of the force that is helping us build up the country, we should understand that we should analyze him and we should know him better than we do. I have always had the most loyal support of any men that I directed on work, and they felt that I wasn't afraid to talk with them, not afraid to discuss matters with them and not afraid to listen to them. I am willing to admit that I have received many a good suggestion from a man who bore no relation whatever, as far as training or education was concerned, to an engineer; and the absolute joy that it was to an ordinary workman to see me adopt something that he suggested was more than dollars and cents or an increase in the pay check.

I have never had them hesitate to undertake the most dangerous and desperate work in washouts, in trouble when things didn't go as they should go; and I always felt a kindly regard for them. Early in my engineering career I specialized more or less in bridge work and I handled bridge erecting crews. And there is no better class of workmen, or wasn't in my day, than the bridge erector—or structural iron worker, as you call him now. He was willing to do anything if the engineer in charge told him to do it. He was willing to take any chance that might appear a chance to him and go in the most dangerous place. And I have always had a high respect for him for that reason. That is why, as I said at the beginning of the talk on labor, the engineer should really understand labor better than he does. He should have been the leader of labor. He should have been the man whom they would look to for advice and for help. But, I must say again, unfortunately the engineer has not. Whether he has been afraid of himself or for whatever reason, he has not established that close relation with the men that he was working with or who were working for him, that he should have established.

Results of Test of a 4-Way Reinforced Concrete Slab Floor.—The Engineering Experiment Station of the University of Illinois has issued a bulletin giving the results of tests on a 4-way reinforced concrete flat slab floor of the Western Newspaper Union Bldg. in Chicago, Ill., just before it was razed in 1917 to secure space for the present Union Passenger Station. The tests were conducted under the general supervision of Professor Arthur N. Talbot and the direct supervision of Harrison F. Gonnerman, Research Associate in Theoretical and Applied Mechanics in the Engineering Experiment Station. The floor construction used in the first five floors of the building was slab and girder type while that of the upper three floors was Turner mushroom flat slab type with 4-way reinforcement. The tests were made on the sixth floor. A test load of 913 lb. per square foot was applied over four panels each 17 ft. 5½ in. by 19 ft. 4½ in. This load was considerably greater in proportion to the design load than had ever been used in previous tests of buildings. The information secured, therefore, which shows the action of the slab in its various parts given by the strain measurements has an important bearing on the design of the flat slab structure. The text of the bulletin is adequately illustrated by means of photographs and diagrams in which such data as the following are given: "Arrangement of Reinforcement in Test Area," "Location of Gage Lines on Upper and Lower Side of Slab," "Load-deflection and Location of Deflection Points," "Load Strain for Gage Lines on Reinforcing Bars on Upper and Lower Sides of Slab." Copies of the bulletin may be had gratis by addressing the Engineering Experiment Station, University of Illinois, Urbana, Ill.

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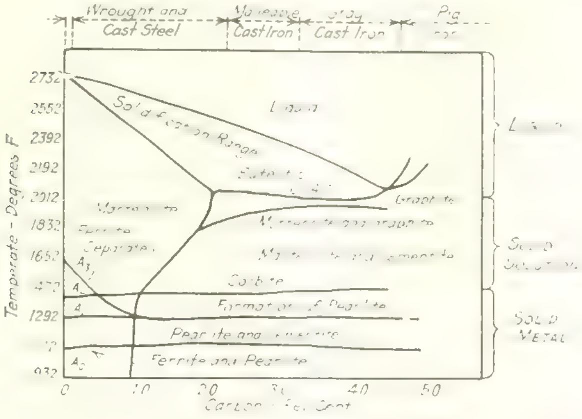
*[illegible] W. H. [illegible] President of the Chicago & [illegible]

Effect of Rolling on Rusting of Iron and Steel*

It has been observed that some of the older iron resist corrosion better than the modern rolled iron product (the term iron is used in its general sense and includes the various rolled shapes whether from the Bessemer process or other well known processes).

Now in attempting to throw some light on these corrosion problems you may or may not agree with the speaker's point of view, but you must all admit the fact that modern rolled iron does not successfully withstand the elements of oxygen and moisture although its chemical refinement is almost that of pure iron. To begin with, it is contended by the speaker that the chemistry of iron or steel plays a very minor part in the behavior of the finished product, insofar as the influence of corrosion is concerned. Other influences in the manufacture of rolled iron products such as a laminated structure surely play an immensely major role as will invariably be admitted by those who have been keen observers of the relative destructive influences taking place on the various parts of bridge structures. Many striking examples of this view can be pointed out.

For instance, the 100-year-old link chain suspension bridge at Newburyport, Mass., has attracted much attention among metallurgists because it has suffered from corrosion scarcely at all and has had comparatively little painting or artificial protection. The only irons which we can find to have lasted better than this are cast iron pipes or cast iron structures—some of which were put into service 250 years ago and are still in use. Some metallurgists have laid claim to the chemical purity of these old iron structures and they have thus tried to explain their long life, but such a claim has been completely destroyed by removing and analyzing one of the old chain links from the bridge at Newburyport, and according to a recent printed report: "Some of the links have been examined and found to be of very ordinary purity and of a most heterogenous structure, segregation of the impurities being decidedly noticeable. The question of inherent superiority in the iron itself was settled by heating and rolling one of the links into a sheet and exposing it to the weather, when it was found that it corroded quite as readily and extensively as the rolled material of today."



In Fig. 1, which is a reproduced drawing from a standard text book on Metallography, there are indicated the various commercial grades of iron products familiar to all of you. Beginning with the pig iron it will be noted that the carbon content is greater than 5 per cent. Next comes gray iron with a carbon content of 3.2 per cent to 4.6 per cent. White cast iron is next with a carbon content ranging from 2.2 per cent to 3.2 per cent. The iron which has a carbon content less than 2 per cent is generally known as steel and this material may be rolled or manipulated mechanically while cold or at a red heat whilst all other classes of iron must be cast into their desired shapes or forms. Glancing at the left-hand side of the chart, the various temperatures at which iron melts and freezes or solidifies may be observed. It will be noted that these temperatures are somewhat lower for gray cast iron than for steel and are yet higher for pig iron than for gray iron. These very high temperatures; that is, those above 2,000° F., have no significance for the iron members used in bridge construction except that they indicate the degree of heat at which the large steel ingot was cast. These ingots are rolled into various shapes at temperatures more than 1,000° F. below the freezing or casting point of the metal. The metal itself is worked at excessively high speed and inasmuch as the reduction in the cross-sectional area of the billet is made at infrequent passing through the rolls the metal does not attain its full crystal growth which can only be restored to the internal structure by raising the temperature well up within the solid solution range or by entirely remelting. If the final rolling of steel members takes place below the solid solution range, decided lamination of the structure is apt to exist and such steel is known to succumb very rapidly to oxidation.

This explanation of corrosion phenomena seems to be entirely borne out by the fact that cast steel, cast white iron, cast gray iron or cast pig iron whether they have a siliceous skin surface or not, all resist corrosion almost equally well whilst rolled iron deteriorates at a rapid rate. Careful observation of corroded iron will show that rolled iron disintegrates into large flakes of rust whilst cast steel and cast iron take on a permanent oxide coating which inhibits further deterioration.

Now to explain why some of the rolled iron made 40 or 50 years ago behaves better than the modern rolled product we have only to compare the methods of rolling and the speed of producing a given section of metal. In former years more passing of the metal at lighter draughts through the rolls was one feature; another was the more uniform manipulation by slower processes. Moreover, this explanation is further borne out by the more rapid deterioration of parts of modern rolled members, such as the web of a steel rail which flakes off in rust scales more rapidly than the part of the section such as the ball or flange, both of which have undergone less internal structural deformation.

To engineers interested in obtaining a higher rust resisting metal for modern bridge structures there seems to be a tentative recommendation that can be made to the effect of establishing the final heat treatment of rolled members well up within the solid solution range for the rolled product and at the same time requiring a lesser, slower and more uniform degree of crystal deformation. By combining these two factors, it is the speaker's opinion, we can look forward to improvement.

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*From a [illegible] Mr. H. [illegible] Inspection and Report [illegible] before the [illegible] Club.

Employment for Engineers.—The professional and special section of the United States Employment Service, formerly located at 29 S. La Salle St., Chicago, has removed to new and more extensive quarters at 63 E. Adams St., Chicago. This section, formerly known as the Division of Engineering, will enlarge its service to include all kinds of professional and technical men and women. During the war this branch of employment did notable work in placing engineers and technical men in various branches of the war and the Government. Now its activities will be directed toward reconstruction and peace needs. It will serve employer and registrant alike and will strive to place the best man in the place where he is most needed. No charge is made for this service. Engineers and professional men and women desiring the services of the Professional Section are requested to write to the above address for registration blanks. In order to secure quick service, applicants are advised to communicate with the branch of the Professional Service which has jurisdiction over their zone district. Those people living in Illinois, Indiana, Iowa and surrounding territory should register with the Chicago office.

Minnesota Cities May Reimburse Contractors for War Losses. A bill is before the state legislature of Minnesota authorizing cities of more than 50,000 population to reimburse contractors on municipal work for losses due to war conditions.

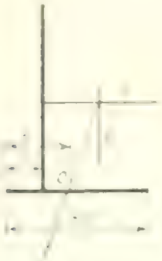
Conditions for Economy in Reinforced Concrete Wall Design

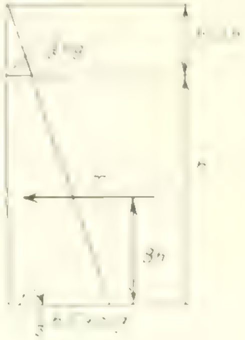
[illegible]

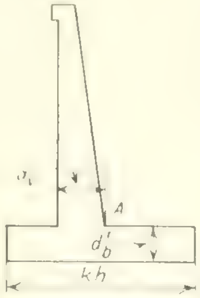
[illegible] counterfort [illegible] designs [illegible] method [illegible]

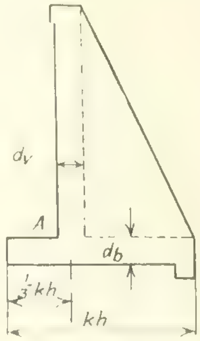
[illegible] control the selection of [illegible] economically [illegible]

[illegible] may, each in turn, control the necessary thickness of the several parts of the wall as the height varies. It is to be noted, however, that [illegible] usually require about the same thickness of section, though, probably a greater variation in the amount of reinforcement required. In assuming, then, that the wall dimensions follow the theoretical requirements a large percentage of actual cases are covered and, if these dimensions are taken in accordance with the stress of simplest expression, no serious error results. With this in mind, the various thicknesses of both the cantilever and the counterforted are those given by the bending moment requirements.









Before entering into the comparative economy of the two general types of walls, it may prove serviceable to establish some general properties governing all types of reinforced concrete walls.

By ignoring the difference in weight between the masonry and the earth, the ratio between the width of base and the height of wall may be expressed quite simply as follows: Using Rankine's expression for the thrust with a horizontal upper surface and with the angle of repose 30°, together with a surcharge of depth h′ the thrust is found to be

$$T = g\frac{h^2}{6}(1 + 2c) \qquad (1)$$

where c is the ratio h′:h.

The thrust is located at the center of gravity of the applied loading, a distance B h above the base, where B is found to be

$$B = \frac{1}{3}\,\frac{1 + 3c}{1 + c} \qquad (2)$$

The weight G is w (1—i) h (1 + c) g, and the lever arms about P and O are respectively

[illegible]

[illegible] kh

Taking moments about P and O and eliminating the irrelevant factors, k is finally found to be

[illegible] (3)

Clearly, the least value of k is given when the denominator of the second radical is a maximum, or when $(i - e)^2$ vanishes [illegible]. Thus the most economic section is to be had when the location of the vertical arm is just over the point of application of the resultant.

In the work that follows, since it is a comparative estimate of the cost of the two types of walls that is sought, it is justifiable to select as a type for the present analysis, that giving the simplest expression. It is quite clear that variations in the toe length, or in the assumed position of the resultant, will not affect, to any material extent, the comparative estimate. For this reason the last established general condition of economy, i = e is adopted, with a further provision that e = ⅓ — which is the usual goal in retaining wall design. With these conditions equation 3 becomes

$$k = \frac{1}{2}\sqrt{\frac{1 + 3c}{1 + c}} \qquad (4)$$

In a reinforced concrete section the resisting moment is given by

$$M = K\,bd^2 \qquad (5)$$

K is a constant depending upon the unit compressive strength and the percentage of steel adopted. For an economic section, the percentage of steel is about 0.75 per cent, and since $K = .5kjf_c$ (the nomenclature of the Special Concrete Committee of the Am. Soc. C. E. is used here) with this percentage of steel $.5kj = 0.17$ and if a value of f_c of 650 lb. per square inch is used, and then expressed in pounds per square foot, K = 16,000. Using b = 1, M is then

$$M = 16{,}000\,d^2 \qquad (6)$$

The bending moment due to the thrust is T B h, and replacing by the values previously found becomes

$$M = \frac{1}{18}\,g\,(1 + 3c)\,h^3 \qquad (7)$$

With g the usual value 100 lb. per cubic foot and equating equations 6 and 7

$$d_v = .0186h^{\frac{3}{2}}\sqrt{1 + 3c} = C_v h^{\frac{3}{2}} \qquad (8)$$

In getting the moment for the footing, using the value of k as given in equation 4, it is found that the footing moment is about 0.7* of the arm moment as found in equation 7.

and the required thickness of the base slab is

$$d_b = \sqrt{.7}\,d_v = 0.84\,d_v \qquad (9)$$

In the counterfort walls, if m is the distance between the counterforts and the moment is taken as $\frac{Wm^2}{12}$ (i. e. the slabs are assumed continuous), then since

$$W = \frac{g}{3}\,h\,(1 + c)$$

the moment becomes

$$M = \frac{gh\,(1 + c)\,m^2}{36} \qquad (10)$$

Adopting the same concrete constants as before and equating this moment to the resisting moment

$$d'_v = .0132m\sqrt{h\,(1 + c)} = C'_v\,m\sqrt{h} \qquad (11)$$

At the outer edge of the footing, since the soil intensity is

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*Exactly the base moment is

$$M = 1 - [illegible]\,\frac{gh^3\,(1 + 3c)}{18}$$

where [illegible] when [illegible] 1/3.

zero, the weight on the slab is that of the superimposed earth or

$$W = gh\,(1 + c)$$

The moment is then

$$\frac{gh\,(1+c)}{12}\,m^2$$

or three times the corresponding vertical slab moment, whence

$$d' = d'_v\sqrt{3} \qquad (12)$$

The counterfort is usually about 1 ft. thick and will so be taken here.

The cost of the steel rods is a small part of the total cost of the wall and the relative difference in cost of steel rods between the two wall types would thus be negligible.

The amount of face forms for the vertical arms of either type is the same and is thus ignored. The variable factors of importance in the two types of walls are then, the concrete yardages and the face forms of the counterforts.

Let L be the total length of wall taken, r be the cost per cubic foot of placing the concrete into the wall (the cost of placing concrete is substantially the same for both types) and finally t be the cost of the forms per square foot. For the counterforted wall, the amount of concrete is

$$L\,(d'h + khd') + \frac{L}{m}\,\frac{kh^2}{2}$$

and the total cost of the concrete is then

$$Lrh\left(d'_v(1 + k\sqrt{3}) + \frac{hk}{2m}\right) \qquad (13)$$

The cost of the face forms of the counterfort is

$$\frac{1}{2}\,Lkh^2 \ [illegible] \ \frac{L}{m}\,2$$

making the total cost of this wall (Meaning the total cost under investigation)

$$Lrh\left[d'(1 + k\sqrt{3}) + \frac{hk}{2\,m}\left(1 + 2\frac{t}{r}\right)\right] \qquad (14)$$

In the "T" cantilever wall, the width at the coping is taken as one foot and the back battered unbrokenly to the required thickness at the base. The volume of this wall is

$$L\left(\frac{1 + d_v}{2}h + khd\right) = Lh[\tfrac{1}{2} + d_v(\tfrac{1}{2} + 0.84k)]$$

and the total cost of the wall is thus

$$Lhr[.5 + d_v(.5 + .84k)] \qquad (15)$$

Equating (14) and (15)

$$d'(1 + k\sqrt{3}) + \frac{hk}{2m}\left(1 + 2\frac{t}{r}\right) = .5 + d_v(.5 + .84k)$$

Replacing the thicknesses of the sections by their values as found above

$$C'm\,h(1 + k\sqrt{3}) + \frac{hk}{2m}\left(1 + 2\frac{t}{r}\right) = .5 + C\,h(.5 + .84k)$$

Later it will be shown that the economic spacing of counterforts is given by $m = 3.1\,R\,h^{\frac{1}{2}}$, where $R = \sqrt{1 + 2\frac{t}{r}}$

Using this expression, there results a quadratic in $h^{\frac{1}{2}}$

$$C\,h - R\,C'\,h^{\frac{1}{2}} + .5 = 0$$

where $C' = .0132\,[illegible]\,1 + c\;3.1\,(1 + k\sqrt{3}) + \frac{k}{6.2}$

$$C = .0186\,(1 + 3c)(.5 + .84k)$$

giving a value of h

$$h^{\frac{1}{2}} = \frac{RC' \pm \sqrt{R^2C'^2 - 2C}}{2C}$$

Table I gives a series of values of h for several values of the ratio t/r and of the ratio h′/h or c.

Economic Spacing of Counterforts.—To determine the spacing of counterforts to give the most economic wall sections, it is seen that equation 14 is the required expression for the variable cost as the position of the counterfort changes.

If, by the theory of Minima and Maxima, the derivative of this expression with respect to m is put equal to zero, there results, after again replacing the several thicknesses by their values as previously found

$$m = \sqrt{\frac{[illegible]\left(1 + 2\frac{t}{r}\right)}{2C'\sqrt{1+c}\,(1 + k\sqrt{3})}} = \sqrt{[illegible]\left(1 + 2\frac{t}{r}\right)}\,\frac{k}{.0132\sqrt{1+c}\,(1 + k\sqrt{3})}$$

Putting $R = \sqrt{1 + 2\frac{t}{r}}$

and noting that the expression, after using the value of k as given in equation (4),

$$\sqrt{\frac{k}{(1 + k\sqrt{3})\,\sqrt{1 + c}}}$$

is practically constant and equal to one-half,

$$m = 3.1\,R\,h.$$

Table No. II gives a series of values of m for several values of the ratio t/r and for a range of heights.

It is reasonable to expect that the laws governing the theory of probabilities hold here and thus, that the small errors introduced in the above approximations are compensatory. By several trials and comparisons of actual wall sections it is found that the tables furnish quite an exact clue to both the "critical height" h and the economic spacing of the counterforts.

TABLE I—CRITICAL HEIGHTS OF WALLS

[illegible]

TABLE II—ECONOMICAL SPACING OF COUNTERFORTS

[illegible]

The Engineer and Government Housing Developments

The important part taken by engineers in the housing development undertaken by the U. S. Department of Labor is outlined in the recent report of Mr. John W. Alvord, Chief Engineer of the United States Housing Corporation. Extracts from the report follow.

In connection with the housing bureau program, 60 or more developments projected in various parts of the country have reached the stage of engineering planning. These range all the way from 25 to 3,000 families per development, and there have been necessarily planned for this work in the aggregate the following municipal improvements:

180 miles of sewer, costing about $2,[illegible]
160 miles of water pipe, costing about $2,[illegible]
11 independent pumping stations for water supply.
[illegible] miles of gas lines, costing about [illegible]
[illegible]
135 miles of street paving, curb and gutter, costing [illegible]
200 miles of sidewalk, [illegible]
2,877 street lights.
[illegible] sewage pumping plants.
13 sewage treatment plants.

The total cost of all contemplated municipal area utility improvements will approximate $13,060,000.

The Engineering Division has been largely composed of municipal engineers, especially skilled in municipal work, assessment law, city regulations, precedents and practices. Through its negotiations it has obtained aid from municipalities to the extent of $3,103,000 or 24 per cent of the total cost of the total utility and municipal work contemplated.

The Engineering Division has further been entrusted with the negotiations with private utility companies for the necessary service for the bureau developments of gas, electric lights, water-supply, and, in some few cases, of heating facilities and telephone service as well. In all some 250 negotiations have been conducted, a large portion of which have been brought to a successful termination. In [illegible] had been financed through approval of the Capital Issues [illegible] available, utilities have at times been financed by the bureau [illegible] able.

In every case, it has been urged upon utility companies that they ought to accord the bureau the same service, if not more service, than they would accord a private investment [illegible] of the situation has required contract relations or negotiations with 48 [illegible] water companies, or about 150 utility companies in all.

The Engineering Division, through its negotiations and [illegible] investment from utility companies for United States housing to the extent of $1,600,000, or 12.3 per cent of the total cost of utility investment. The total amount raised by suggestion and negotiation of the Engineering Division from municipalities and utility companies for United States housing requirements has been $4,702,700, or 36.2 per cent of the total requirements of $13,040,134, estimated utility expenditure. Of the $4,702,700 raised from municipalities and utility companies, about one-half or 2,216,900, has been financed by the municipalities and utility companies, and the remainder loaned them by the bureau, to be repaid by the Government in the near future.

The Engineering Division has been employed in making preliminary investigations for the bureau in connection with the selection of local sites for housing developments. This matter has been handled by a committee consisting of an engineer, an architect, a realtor and town planner, and in each case all sites offered or suggested have been carefully canvassed, their development cost estimated, and the selection made on the basis of actual desirability regardless of all private interests.

The Engineering Division at the central bureau consists of a chief engineer, an engineering secretary to the chief, a chief assistant, 10 district engineers (each of whom has conducted the individual details of a group of projects), two utility engineers, one road engineer, one fire-protection engineer, two electrical engineers, an attorney on contract relations, and an engineer in charge of engineering contracts, bills and accounts, and four stenographers—about 25 in all. The duties of the central staff have been:

1. To prepare a manual of standard directions for local project engineering designers, and
2. Standard instructions, drawings and specifications and directions.
3. To act as adviser to other divisions on engineering questions.
4. To report on all unusual or difficult engineering problems, such as constantly arise.
5. To select, appoint and contract with all local project engineers and their assistants.
6. To guide and direct the local project engineers.
7. To revise the budget allowance in accordance with the policy of the bureau.
8. To initiate and conduct all contract relations with city and utility companies.
9. To approve all detailed plans, estimates and specifications of such local project engineers and control their operations.
10. To check the bills of material.
11. To advise the town-planning and construction divisions on all engineering questions.

In the field of some 60 local project engineers have been appointed who have been either persons or firms having locally efficient office, organization, acquaintance, equipment and financial ability in addition to specialized training in municipal problems, and who could do rush work on short notice in the preparation of plans, conducting negotiations and the supervision and construction of local development projects.

Contracts with the local project engineers have been on a uniform contract form prepared by the Engineering Division, and based on a scale of fees less than ordinarily earned but thought to be sufficient, in which all contracting engineers have been uniformly treated alike. The fees and overhead expenses have been on a sliding scale, reducing in cost per house with the increase of the development, and prepared on the basis that the municipal improvements would vary approximately with the number of houses in each development. The average of fees and overhead allowance has been but 1 per cent on the cost of utilities involved, amounting to about $2,500 on a 200-house development, and increasing to about $4,500 on a 1,000-house development, in addition to which the project engineer received actual cost for his assistants, the traveling expenses and such obvious expense as could be readily checked by the fiscal division.

Cost of Applying Stucco With the Centrifugal Stucco Gun

A somewhat difficult stuccoing job was carried out recently at Cincinnati, O., with the Hodges centrifugal stucco gun. The building was constructed with studding put up on the same principle as for a frame house. The studdings were fluted out on each side and concrete was poured between. After the framework had been removed a very thin coat of plaster was applied to the exterior surface. Evidently this plaster was put on before the timber had absorbed all the dampness it was possible for it to absorb and as a consequence the plastering cracked opposite each studding. It was decided to cover the timbers with a coat of stucco. The walls were completely cleaned of all dirt and foreign matter and were wet by means of a high pressure hose. This was done 24 hours before applying the cement mortar. The walls were again wet a few hours before the stuccoing was put on. These wettings saturated the timber so thoroughly that it was impossible for it to expand any more from the dampness of the stucco. Two machines were used in applying the stucco. Each machine had an operator at 70 ct. per hour and a helper at 45 ct. per hour. In addition one man at 45 ct. per hour was employed in mixing the material. The labor cost of ap-

Applying Stucco with Centrifugal Gun.

plying the stucco was 15 ct. per square yard. The sand cost $3.00 per cu. yd. or 2 ct. per square yard of stuccoed surface; the cement cost $3.20 per bbl. or 6 ct. per square yard of surface. The total cost of the finished job was therefore 23 ct. per square yard.

How Architects May Secure More Extended Recognition

Engineers, by their energy and success in gaining the public ear, are fast driving the modest, timid architects out of business, stated Mr. George Hancock in his presidential address before the North Dakota Architects' Association. To offset this tendency, he continued, we notice that many architects, in order to keep up with the procession, have added the title of engineer to that of architect for the purpose of impressing the public with their superior qualifications over and above that of the properly trained architects who make no claim to other professions. Architecture and engineering are two separate and distinct professions, and it is given to but few men to master the intricate details of both, so that in most cases the assumption of the dual title is used for the sole purpose of gaining advantage over those who do not have the temerity to adopt such with little or no preparation.

The Massachusetts Institute of Technology makes the distinction between architecture and engineering and has separate courses for the training of students in each, as either is all that the average intellect can properly master with credit to himself. So that the mere adoption of a title without the necessary training to properly sustain it should at least be discouraged by all self-respecting architects.

Some professions, such as the law, are held in less esteem than that of architecture, and if we would increase respect for our profession we must command it through our work and that will bring us the public recognition we so urgently need.

It is useless for us to look to the law courts for protection, as the lawyer is the only winner where such efforts are made, but as a reason for hope in the improvement of our chosen calling, we have only to look at the host of poorly paid teachers and clergy to learn that our lot is no harder than theirs, in the matter of lack of appreciation of the service they render to the public. It is well to think of others when disposed to complain of our lot.

If we could succeed better than they we must do better and nobler work, with our minds set more on achievement than on temporary financial success. It is futile to complain that this is a commercial age, with but little public appreciation of art; such whining does no good and only indicates weakness. There is just as much artistic taste and feeling in the world today as in the days of Titian and Michael Angelo, and it is for us to satisfy this artistic taste and feeling if we would succeed in gaining for our profession the respect and recognition to which we believe the nobility of architecture is entitled.

During the past 10 centuries architecture has come through many changes and developments. The eighth and ninth centuries gave us the unique creations of the Saxons; the 10th and 11th centuries the solid, honest Norman work that has so well stood the test of time, as evidenced at Winchester and Durham.

The 12th and 13th centuries gave us the pure and graceful early French and English Gothic that so clearly expresses the aspirations of the people of those nations in the magnificent creations of Rheims and Amiens, Salisbury and Westminster, the like of which has never been seen before or since that age. The 14th and 15th centuries gave us the geometrical and perpendicular styles, often referred to as the climax and full development of gothic architecture in Europe.

Such art and architecture as the people of those times produced should serve as a stimulant to greater efforts of the younger architects of our time. They had no examples to guide them and their work was the result of creative and imaginative concentration and skillful independent effort.

Shall we then, with all these beautiful examples before us and the numerous examples of the Renaissance of the 16th century, and the more recent productions of Jones and Wren and the revival of the Romanesque by Richardson and Hunt in this country, fail for the lack of making an effort to merit the recognition we so earnestly crave? No, we must attempt much even if we accomplish little, but as effort is the parent of results, we can expect no recognition by the public unless we command its attention.

By education and experience the architect of today should be better qualified to handle successfully building operations of all kinds than men not having such qualifications, but the public cannot appreciate this for the reason that the architects have not done their part in the instruction of the public to the point of appreciation of their service to their clients and to the public in general.

So far, along this line, our efforts have been limited to talking to ourselves through the medium of professional and trade journals, that seldom or never reach the eye of the general public, or prospective client.

Undue modesty on the part of the trained architect is doubtless the cause of this shyness and should be overcome by a much-needed change in the method of bringing the client and architect together, on a better and fuller understanding of their relationship to each other, and to protect the public from the trickery of the faker and charlatan who is ever ready to pluck the fruits of honest effort along all professional lines. The men who have fitted themselves by great expenditure of money and time to serve the public in an honest and skillful manner must have some protection as against quacks who have no training in architecture and who do their work by proxy and only see the commission or money side of the profession.

The licensing of all architects is a reasonable solution of the problem.

The Architect of Tomorrow*

In the first place, he will be an organizer rather than an individual; a directing, discriminating motive force at the center of a combination of forces, and that organization or combination will be just as essentially a business one as the United States Steel Corporation or the Standard Oil Co., and exactly the same principles of economy, material efficiency and careful attention to detail will of necessity manifest themselves. This organization will be prepared not only to carry out work on definite lines, but to pledge itself that they will be carried out right and on time. In other words, it will guarantee results, and not be able to avoid responsibility by sheltering itself behind a cloak of professionalism. I do not believe that it will assume all the functions that we now hand over to the master builder, any more than I believe the master builder will lose materially in his particular line, but it will have a greater degree of direct contact with the mechanics, many times, I believe, a direct hiring of them on behalf of the owner and a general direction of the work which is now very often in the hands of brokers styling themselves master builders. And the fact that this organization is to free itself from mere professionalism and abandon the cloister or studio point of view, will necessarily bring it into the world's markets so that it will have direct contact with the producing factors that enter into a building. It may even direct these producing factors and be a part itself of the producing side; and still further, as all large works have to be financed, I see no reason to doubt that the architect will hold an important position as an administrator, and therefore necessarily, to a certain extent, as a financial agent.

Furthermore, this organization will be formed not to win a competition or to impress a susceptible public, but to carry out building. The kind of organization that will win a competition is pure theory, and pure theory is what we must avoid. The organic development of building, if looked at right, is pure architecture, and that it just what the world wants. It is to be hoped that the future may see a larger abolition of that unfortunate method of bringing oureslves before the public which we call competition. The true competition always is in the finished product, but the idea that by a series of drawings an architect can win recognition is, I believe, at the bottom of a good deal of our present limita-

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*From an address by [illegible] before the [illegible] Architect [illegible] brought home to us. We are still passing through the mill, [illegible] equipment for victory.

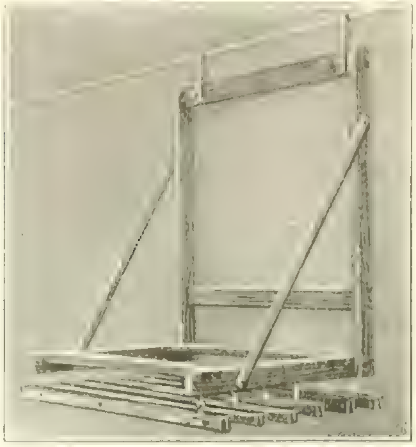
[illegible] The trouble with so much of our pre-war architecture was not that it was too artistic, but it was not artistic in the right senses, in that it was not fit and appropriate for its purpose. Ruskin's emotional stone carver who, just for the love of carving, would cut a wondrous bit of detail way up in an obscure loft, where no one would ever see it, could keep on doing just that sort of thing sometimes, but he would not be in the architectural spirit. [illegible] and not in a real building. Architects are to build real buldings, and the man who would waste that kind of sentiment would be out of place in the very practical, very tense and very demanding world of after the war. The best art always has been the art which was the most real in its application. Architecture would still be the mother art, but the architect, while admitting the pre-eminence of the artistic thought, would, I should [illegible] is not preeminent of material which is simply blossoming for itself without a distinct purpose, and the architect who thinks for a moment that the contemplative, aesthetic point of view, delightful as it is, necessary in a certain degree, as it has been found to be, will suffice for after-war conditions, is bound to receive a harder jolt and a more bitter disappointment than in these parlous days of 1918. To paraphrase the poet, architecture is real, architecture is earnest, and mere unrelated beauty is not its goal. A dream of pure art, a dream of beauty cannot be spoken of the real soul of a building.

Nor does the foregoing imply the elimination of the individual. There have been some wonderfully endowed men like Wren, Mansard or Bulfinch, who seemed to be able to compass all sides of our profession and to properly subordinate the relative factors; but, after all, most of us work best in harness and with limitations, and the very fact that an organization implies subordination of one part to the other is a salutary restraint on the development of the unessential. Again, a man might be just as strong and true alone by himself as he would be as an individual doing similar things at the head of an organization, but somehow I cannot help feeling that the individual architect will be much more of a rarity in the future than he has been in the past, and that in organization, in co-operation, and specializing within the limits of a firm, architects will find their best opportunities.

Filing System for Blue Prints and Drawings

A filing system in which every blue print or drawing is instantly available has been brought out by the National Co., 279 Congress street, Boston, Mass. The system consists of a folding wall rack and special holders for blue prints, records, charts, drawings, etc. The rack, as shown in the illustration, [illegible] can be suspended by hooks [illegible] to the wall. When not in use the rack can be folded back against the wall. The rack let down, as shown, occupies a space of 24 in. by 20 in. by 30 in.; folded against the wall it is 24 in. by 4 in. by 30 in. Each rack holds six removable holders giving a capacity of 500 prints. These holders are made of two pieces of oak. The binder strips are held together by three catches. By pressing on these catches the top binder is relieved and prints can be added or removed. An index card in a frame shows the contents of the holder. Each holder takes 1 to 85 prints and can be laid on the table as a binder while looking over prints, or can be hung by hooks, as indicated in the cut.

Blue Print and Drawing Holder.



Folding Wall Rack.

Personals

The Southern Engineering Co. of Charlotte, N. C., has opened an office at Columbia, S. C. M. E. Boyer, Jr., is in charge of the office.

J. A. L. Waddell, consulting engineer, Kansas City and New York, has been elected a corresponding member of the Society of Engineers of Peru.

Frank C. Emerson of Worland, Wyo., has been named as state engineer of Wyoming to succeed James B. True, who has asked to be relieved to resume his private practice.

Capt. R. McC. Beanfield, formerly topographical officer of the Eighth Mounted Engineers, has been honorably discharged from the service and entered the service of the Emergency Fleet Corporation as engineer of shipyard plants division, Philadelphia, Pa.

Fred Hubbard has resumed his duties with the Carnegie Steel Co., Youngstown district, with the title of construction and engineering superintendent. Mr. Hubbard was formerly chief civil engineer and as such laid out the McDonald plant and supervised building of the model town. Until the war closed he was in charge of laying out the plant and town for the Neville Island Project of the Government.

Charles J. Bennett of Hartford, Conn., has been elected president of the Connecticut Society of Civil Engineers. The other officers are: First vice-president, Thomas A. Scott, New London; second vice-president, J. Frederick Jackson, New Haven; secretary and treasurer, Henry J. Kellogg, New Haven. The directors elected were as follows: William R. Dunham, New Haven; Charles C. Ellwell, New Haven; Leon A. Peck, Hartford, and R. A. Cairns, Waterbury.

Maj. H. M. Montgomery has been discharged from the service and has accepted the appointment of commissioner of public works and city engineer of the City of Evanston, Ill. Maj. Montgomery built two warehouses, water works and fire engine house for the Jeffersonville Quartermaster Interior Storage Depot at Jeffersonville, Ind., as constructing quartermaster and disbursing officer and finished the St. Louis clothing warehouse for the St. Louis Quartermaster Interior Storage Depot at St. Louis, Mo., in the same capacity.

Obituaries

Humphrey Jones, stone contractor, Columbus, O., died Feb. 18, aged [illegible].

C. D. Langhorne, one of the leading railway contractors of the south, died Feb. 14 at Richmond, Va.

E. J. Howard, president of the Howard Shp Yards & Dock Co., Jeffersonville, Ind., died Jan. 30, aged 78.

J. K. McLain, builder of the old Kansas Pacific R. R. through Kansas, died Feb. 16 at Excelsior Springs, Mo., aged 73.

David Oliver Holbrook, authority on natural gas problems in America, was head of the division of natural gas of the United States Fuel Administration, died Feb. 16 at Pittsburgh, Pa., aged 47.

Industrial Notes

The Chicago Pneumatic Tool Co. announces the removal of its Cleveland district office from Room 813 to Rooms 406-408, Engineers' building, effective March 1. Ross Watson is district manager.

The Poston Paving Brick Co. of Crawfordsville, Ind., one plant, and the Burton-Townsend Co. of Zanesville, O., two plants at Zanesville and one plant at Ashtabula, O., have become licensees of the Dunn Wire-Cut Lug Brick Co. of Conneaut, O., and will [illegible] the manufacture of [illegible] lug paving brick.

Road and Street Monthly Issue

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The *articles* in the first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering and contracting field. The *articles* in the first and last issues of each month (1st and 4th Wednesdays) completely cover county engineering and highway engineering and contracting. The *articles* in the third and last issues of each month (3rd and 4th Wednesdays) completely cover steam and electric railway location, design and construction. See the "mast head" on the first page of the Weekly News Section for information about our weekly contract news. See Advertising Page 71 for Subscription Coupon.

Roads and Streets—1st Wednesday
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellany

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power

Railways and Excavation—3rd Wednesday
(a) Excavation and Dredging (c) Quarries and Pits
(b) Rivers and Canals (d) Railway Construction—Steam and Electric

Buildings and Structures—4th Wednesday
(a) Buildings (c) Harbors Structures
(b) Bridges (d) Miscellaneous Structures

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How to Determine When to Repave

The economic problem of determining when to retire an old plant in favor of a new one is discussed at length in the Handbook of Mechanical and Electrical Cost Data by Gillette and Dana. Without going into the mathematical derivation of the correct formula, we purpose indicating the method to be pursued in ascertaining when a highway should be repaved because repairs have become excessive.

The first cost of the existing pavement does not enter into the problem at all. Therefore the interest and depreciation annuity charges on the existing pavement are not factors to be considered. All that needs to be known relative to the existing pavement is the prospective annual cost of repairing and cleaning it, plus the excess cost of repairing vehicles that operate over it as compared with operation over a similar pavement whose age is half the total life. This last element of cost is not yet known, so it can not be applied. Since there are no data as to the differences in cost of cleaning pavements of different ages, the factor of cleaning must also be ignored. This leaves only the factor of prospective annual cost of repairing the old pavement; and when this factor equals or exceeds the total prospective annual cost of a new pavement, then a new pavement should be laid.

The prospective annual cost of a new pavement is composed of three factors: (1) Interest on its first cost, (2) depreciation annuity and (3) equated annual repair.

In solving this particular problem it is a mistake to include the first cost of the base or foundation where only the wearing surface must be renewed.

George W. Tillson, in Blanchard's American Highway Engineers' Handbook, p. 1341, gives an illustrative problem that is incorrectly solved. He assumes an asphalt pavement costing $2 a square yard, having a life of 18 years, and a total repair expense of $0.72 during its life. Interest on money is taken to be 4 per cent and the depreciation annuity that will redeem the $2 in 18 years is 7 ct. Then the total annual cost per square yard is:

Interest, 4% of $2	$0.08
Depreciation, annuity	0.07
Repairs, $0.72 ÷ 18	0.04
Total annual cost	$0.19

Mr. Tillson says: "Consequently, if the life of a sheet asphalt be correctly assumed at 18 years, it should not be repaved until the annual cost approaches $0.19 per square yard." This is a wrong conclusion, for several reasons. First, the $2 includes the cost of a concrete base; and while the sheet-asphalt itself may have a life of only 18 years the base will have a much longer life. Second, although the total repairs may be 72 ct. during the 18 years, it is incorrect to arrive at an average by dividing 72 by 18. Repairs to asphalt are relatively small during the first half to two-thirds of its life, and then usually rise rapidly. The correct economic method of estimating an annual average in such cases is what he called securing an equated average. To do so apply this rule:

Calculate the cost of repairs of the first year at compound interest up to the end of the life of the pavement. Make a similar calculation of repair costs for each of the successive years. Add all these compounded costs together and multiply by the annual deposit in a sinking fund which started at the beginning of the life of the pavement will redeem $1 at the end of its life. The product is the equated annual cost of repairs.

Finally, it is not correct to say that "it should not be repaved until the annual cost approaches $0.19 per square yard." As above indicated, repaving is justified when the prospective annual cost of repairing the existing pavement equals or exceeds the prospective annual cost of a new wearing surface.

Why Engineering Regiments Should Be Mustered Out at Once

[illegible] and unskilled, released from war-time pursuits. It [illegible] the transition period the federal, state and municipal author[illegible] and postponed by war conditions, in order that much of the released labor may be absorbed until such a time as conditions become stabilized."

[illegible] almost [illegible] of the war. In this connection we wonder how rapidly the engineer regiments are being demobilized. If adequate preparations are to be speedily made for construction work, thousands of engineers still in the army should be permitted to return to civil life and to their old positions without delay. While it is true that many civil engineers are at present without employment, and therefore seemingly available for any immediate need, it should be remembered that positions are being held open for the engineers who joined the army. Moreover, those engineers are particularly qualified to fill the places that were made vacant by their enlistment.

Engineering societies are being urged to do so many things that there is apt to be resentment at the suggestion of assuming more public duties. But, in view of the pressing need of providing employment on public works, and because engineers must first make surveys and draw plans, should not our national engineering societies take immediate action to impress upon the government the necessity of mustering out the engineering regiments at once?

What Can Be Done to Cause Capital to Flow Freely into Public Works?

Capital flows rapidly, almost automatically, into all lines of investments that are profitable—all except public works. No matter how profitable hard roads, for example, may be to a community, there is rarely an adequate investment of capital in good roads. This results from several causes.

To begin with, little of the profit from public works goes directly to those who furnish the capital. If bonds are sold to secure the money, the bond holders receive a limited and rather small percentage on their investment. Hence there is no great incentive for bond holders to seek to convince the public that more money for road improvement should be raised by bond issues. If the money is secured by taxation, there is a positive and increasing opposition toward the building of better roads, for taxpayers get no direct returns upon the investment and usually are incapable of estimating the indirect returns.

The inability of the average taxpayer to weigh the indirect profit to himself from the money that is taken from him for public works accounts for most of the opposition to road or street improvement, and the like. Coupled with this is the fear that incompetent officials will waste most of the funds raised for improvements.

It seems to us that it devolves upon civil engineering societies to devise ways and means of securing an adequate flow of capital into public works. Engineers, if they are to be economists in a broad way, must not continue to confine their attention to the doing of what they are employed to do. They must show their employers what should be done to increase prosperity. Where the employer is the public, this means that civil engineers should point out and urge amend[illegible] will tend to [illegible] improvements.

[illegible] not only are engineers trained economists but they enjoy the confidence of the public. Whether it is that their scientific training tends to develop honesty or whether it is their freedom from the personal ambitions of most political leaders, certain it is that when civil engineers take action as a body they receive an amount of consideration that is out of all proportion to their numbers.

[illegible] contemplating building a new line, its engineers not only estimate the probable cost but the probable profit from it. Similarly as to all major improve[illegible] Why shouldn't city, county and state engineers do the same? Why shouldn't the public be shown in each instance not only that a proposed investment will be a profitable investment but how profitable?

If it were shown definitely that it would pay to pave every street in a city, it would not be many years before it would cease to be a fact that less than half our street mileage is paved.

City engineers can not be expected to attempt, unaided, to effect charges in laws that restrict municipal improvements; neither can they be asked to act alone as promoters of public works. They need, and should have, the support of their fellow engineers acting as a body.

A Splendid Highway Engineers' Handbook

Although there are many text books and one handbook on road and street work, the field is so great and so rapidly growing greater that another general handbook for highway engineers is welcome.

The American Highway Engineers' Handbook, by Prof. Arthur H. Blanchard, and a corps of 17 associate editors, has just been published by John Wiley & Sons, New York City; its price is $5, and it contains almost 1,700 pages of close print.

The book is divided into 29 sections covering the location, design, construction and maintenance of both roads and streets. At the end of each section is a bibliography of books and of articles in periodicals. Our readers will be interested in the fact that of 622 articles thus credited to 8 periodicals, Engineering and Contracting has 212, or more than one-third of the total, to its credit.

The 29 sections and their authors are as follows:

Sec. 1: Terminology of Highway Engineering (23 pages), by Prof. Arthur H. Blanchard, Columbia University, New York City. This contains the best collection of definitions of highway terms yet published.

Sec. 2: Mathematics, Mechanics and Structural Materials (60 pages), by Prof. Harold S. Boardman, Dean of the College of Technology, University of Maine. This section is necessarily very condensed, but the condensation has been done with excellent judgment.

Sec. 3: Engineering Geology (63 pages), by James F. Kemp, Professor of Geology in Columbia University, and Frederick K. Morris. Prof. Kemp's eminence as a teacher of geology insures the quality of the matter in this section. The bibliography of books at the end of the section will be very helpful to all engineers who wish to perfect themselves in this important branch of road engineering. The geology of rocks and soils has been too often and too long neglected by civil engineers.

Sec. 4: Preliminary Investigations (46 pages), by Walter Wilson Crosby, Consulting Engineer, Baltimore, Md. Mr. Crosby was chief engineer of the State Road Commission of Maryland. His section covers location, grades, widths, traffic investigations, selection of surfacings, estimates of cost and report forms. The bibliography of this section contains 75 references, which alone would warrant the purchase of the book by any engineer desirous of obtaining a complete mastery of the topics discussed by Mr. Crosby.

Sec. 5: Surveys and Office Practice (138 pages), by Henry B. Drowne, Engineer of the Lane Construction Co. This is the largest section in the book. It covers field and office instruments, surveying, maps, grades, vertical curves, crowns, estimates and general data. It contains 50 pages of curve tables and 12 pages of other tables. In the bibliography of the books there is no reference to Fred Lavis' "Railway Location," which is one of the best books published on railway surveying-practice. A great deal that it contains is equally applicable to road surveying.

Sec. 6: Planning of Roads and Road Systems (32 page), also by Henry B. Drowne. This is a very big subject and it is crowded into a very small space. The bibliography contains references to 12 books and 23 articles. It would seem desirable in the next edition to double or triple the number of references.

Sec. 7: Planning of Streets and Street Systems (56 pages), by Nelson P. Lewis, Chief Engineer, Board of Estimate and Apportionment, New York City.

Sec. 8: Grading, Drainage and Foundations (63 pages), by Austin B. Fletcher, Highway Engineer, California Highway Commission. This section is very well written and contains a good bibliography of books and articles.

Sec. 9: Earth and Sand-clay Roads (36 pages), by Joseph Hyde Pratt, Consulting Engineer and Secretary, North Carolina, Highway Commission. This section is satisfactory as far as it goes, but considering the fact that 90 per cent of our present roads are of earth and that the literature upon earth and sand-clay roads is voluminous, it would seem wise to enlarge this section and its bibliography.

Sec. 10: Gravel Roads (34 pages), by Charles J. Bennett, State Highway Commissioner of Connecticut.

Sec. 11: Broken Stone Roads (42 pages), by Arthur W. Dean, Chief Engineer, Massachusetts Highway Commission.

Sec. 12: Bituminous Materials (150 pages), by Prevost Hubbard, Chemical Engineer, U. S. Office of Public Works.

Sec. 13: Dust Prevention by the Use of Palliatives (19 pages), by John R. Rablin, Engineer, Metropolitan Park Commission of Massachusetts.

Sec. 14: Bituminous Surfaces (34 pages); Sec. 15: Bituminous Macadam Pavements (46 pages); Sec. 16: Bituminous Concrete Pavements (92 pages). These three sections, totaling 172 pages, are by Arthur H. Blanchard.

Sec. 17: Sheet Asphalt and Rock Asphalt Pavements (80 pages), by Francis P. Smith, Consulting Chemical and Paving Engineer, New York City.

Sections 12 to 17 inclusive, totaling 426 pages, relate entirely to bitumens and bituminous pavements, excepting 8 pages in section 13. The matter in these sections is excellent, but it seems to us that a disproportionate amount of space has been given to bituminous pavements. Sec. 12, in particular, is relatively too long, whereas sections 8 to 11 inclusive are relatively too short.

Sec. 18: Wood Block Pavements (42 pages), by George W. Tillson, Consulting Engineer to the President of the Borough of Brooklyn.

Sec 19: Stone Block Pavements (38 pages), by George W. Tillson.

Sec. 20: Brick Pavements (50 pages), by Walter Wilson Crosby, Consulting Engineer, formerly Chief Engineer Maryland State Roads Commission.

Sec. 21: Cement-concrete Pavements (64 pages), by Walter Wilson Crosby.

Sec. 22: Street Cleaning, Collection and Disposal of Waste and Snow Removal (62 pages), by William H. Connell, formerly Chief of the Bureau of Highways and Street Cleaning, Philadelphia.

Sec. 23: Car Tracks and Pipe Systems (42 pages), by George W. Tillson.

Sec. 24: Comparison of Roads and Pavements (48 pages), by George W Tillson. We note in this section, page 1341, an incorrect formula for determining when a new pavement must be laid because repairs have become excessive. The correct formula for solving economic problems of this nature is given on page 102 of the Handbook of Mechanical and Electrical Cost Data by Gillette and Dana.

Sec 25: Sidewalks, Curbs, Gutters and Highway Signs (30 pages), by Mark Brooks, Colonel, Corps of Engineers, U. S. A.

Sec. 26: Highway Bridges, Culverts, Retaining Walls, Foundations and Guard Rails (72 pages), by Prof. Harold S. Boardman, Dean of the College of Technology, University of Maine.

Sec. 27: Preservation of Materials Used in Highway Structures (16 pages), by Henry A. Gardner, Assistant Director, The Institute of Industrial Research.

Sec. 28: Financing of Highway Improvements (30 pages), by Nelson P. Lewis, Chief Engineer, Board of Estimate and Apportionment, New York City.

Sec. 29: Organization and Administration of Highway Departments.

The bibliography at the end of each section of this book should be of great value to every studious user of it. On the whole the bibliographical references indicate that great care was exercised in making the selections; but we note several important omissions. Thus, there are only two books on cost keeping on construction work, yet neither of them is listed in the bibliography of Section 15. There is only one book on Clearing and Grubbing, yet it is not listed in Section 8.

A considerable number of pamphlets are listed in the bibliographies, but most of these pamphlets have been either completely or largely reprinted in certain periodicals, yet reference is not usually given to the reprints. Not only are pamphlets likely to be out of print, but they can not ordinarily be found in libraries, whereas files of periodicals are usually available. Hence it seems desirable to list reprints and abstracts of good pamphlets.

Summing up we can say that this handbook has been exceptionally well edited and that it is deserving of a large sale.

North Dakota Proposes $50,000,000 Bond Issue for Roads

To the Editor: This department is pleased to advise you that, among other highway legislation, now under consideration by the assembly in session, two bills of vital importance and moment have been introduced, notice of which no doubt will be appreciated by you.

Early in February a bill, providing for a $4,000,000 bond issue for highway purposes, was introduced, but was subsequently withdrawn because the above sum exceeded the constitutional limit of bonded indebtedness. In its place there has been put under consideration a concurrent resolution providing for an amendment to the constitution, whereby it will be possible to issue bonds for highway purposes not to exceed $50,000,000. If the resolution is approved by the legislature, this proposition will appear on the ballot two years hence, to be voted upon by the people. If favorably acted upon, the next legislature will then be in a position to pass a specific bond issue law.

In conclusion we desire to assure you that there is a very healthy sentiment in the present legislature toward the Good Roads movement and there is every indication that progressive legislation will be enacted.

J. E. KAULFUSS,
Assistant Chief Engineer, North Dakota Highway Commission.
Bismarck, N. Dak.

$500,000,000 for Road Work in 1919.—Expenditures for highway work in the United States this year are likely to amount to a half billion dollars or even more, according to a statement of officials of the Bureau of Public Roads, United States Department of Agriculture. On reports received from state highway departments, the bureau estimates the expenditures for roads and bridges at $385,000,000, or $110,000,000 more than the average expenditures for 1916 and 1917. This estimate does not include, however, the additional Federal funds which will be available if the amendment to the Post Office appropriation bill, making $50,000,000 immediately available and $75,000,000 more on July 1, is enacted into law. Estimated work under control of the state highway departments includes $45,000,000 for the construction of 5,000 miles of road now under contract, $30,000,000 for 4,000 miles of construction ready for contract, $100,000,000 for 16,000 miles of contemplated construction, and $60,000,000 for maintenance of 200,000 miles. Expenditures of counties, townships, and local road districts are estimated at $100,000,000 for the construction of 15,000 miles and $50,000,000 for maintenance of 100,000 miles.

Nebraska Road Institute.—The Second Nebraska Road Institute will be held March 10 to 14 at the University of Nebraska, Lincoln, Neb The Institute will be conducted by the College of Engineering of the university, with the co-operation of a number of Nebraska road builders. The program will include discussions of Nebraska's new road laws, proposed change of the Federal aid act of 1916; financing hard surface roads, construction and maintenance of different types of road surfaces, stone and gravel concrete work, location and preservation of corners of land surveys, preliminary surveys for permanent roads, sand hill roads, and tractors. Clark E. Mickey, University of Nebraska, Lincoln, is chairman of the Institute.

Cost Keeping for Highway Contractors*

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[illegible] Washington, [illegible] "Highway Cost [illegible] [illegible]

[illegible] articles on [illegible] the last 14 or 15 [illegible] who apparently [illegible] The only cost [illegible] for me. It has [illegible] after the final [illegible] Then I am sat[illegible] and my luck. But if my bank balance is smaller at the end of the job, to h— with my luck, my methods and my men."

This is the attitude of many a practical man, but to all such a word of advice may prove helpful. While luck cannot [illegible] cost keeping it [illegible] a change both in [illegible] foremen, and superintend[illegible] the leading object in keeping [illegible] costly way of doing a given kind of work and the most efficient bosses. Since this is the main object, it follows that an effective cost keeping system must show the unit costs at the end of every week, and if practicable, at the end of every day. But to accomplish this purpose it is usually necessary to cut out all hair-splitting, such as most accountants and bookkeepers indulge in. Rough and ready methods of estimating the number of units of work must frequently be adopted; approximate estimates of overhead costs must nearly always be used; and, in short, the aim must be to get at the unit costs within a few per cent—say 5 per cent—rather than "to the last red cent." It is that "last red cent" ideal of the bookkeeper that is accountable for the practical failure of many a cost keeping system.

As an illustration, take almost any dirt digging job and try to apply the usual bookkeeping methods to it. The timekeeper may report each day the day's labor cost of excavating, but he does not ordinarily ascertain the yardage of earth moved that day. Perhaps the engineer can give a rough estimate of the yardage, but this estimate may be 25 per cent off, for he usually makes his guess merely by looking at the map profile or at the cut and fill marks on the slope stake and then looking at the partly graded roadbed. Since the engineer seldom makes a careful quantity estimate oftener than [illegible] not always careful then—it follows that there are very few grading contracts on which the cost per cubic yard of earth excavated is known within 10 or 15 per cent at the end of each week. As for knowing the earth yardage cost for each day, how many members of this association have ever seen a contractor who did know it?

Estimating Excavation Yardage Daily.—For a long time the author regarded it as impracticable to estimate earth yardage costs with resonable accuracy oftener than at the end of each week. Several weeks ago the author's brother, W. A. Gillette, devised a method of estimating earth yardage on grading jobs every day. The method consists in mounting a timekeeper on a horse and having him ride from gang to gang all day long, stopping 20 to 30 minutes at each gang. If a gang is excavating with fresno scrapers, for example, the timekeeper counts the number of fresno loads taken out by the gang in, say, 20 minutes; and he records the count for that gang. Then he rides on to the next gang which, let us say, is loading earth by hand into wagons. This gang is timed for, say, 30 minutes, and the wagon loads are counted.

In the course of the day each gang is thus visited and its output counted several times. If, for example, gang No. 1 has been visited 3 times and during a total time of one hour it has turned out 50 fresno loads, it is then estimated that it would turn out 400 loads in 8 hours.

An estimate is made of the average size of a load, and the total yardage output of gang No. 1 for that day is estimated. Similarly with the other grading gangs. At the end of the month the totals thus estimated are compared with a careful monthly estimate based on cross-sections. After a little experience it is possible thus to estimate within 5 per cent of the actual yardage moved.

Of course this intermittent count method can not be expected to give satisfactory results unless good judgment is used in its application. But it has been shown to the author's satisfaction that the method is sufficiently reliable when properly supervised. That it is simple, is self evident.

The two greatest obstacles to the successful use of any cost keeping system are, first, a fairly accurate measurement of the number of payment units of work done each day, and second, a correct ascertainment of the total time lost or wasted by each gang. By "payment units" is meant the units of work for which a contract price is paid, as, the cubic yard of earth excavation, the square yard of pavement, etc.

All costs should be finally reduced to so and so many cents or dollars per payment unit, so that the contractor can compare them with his contract prices. Fortunately the highway contractor has a relatively simple task in devising methods of measuring most of the payment units every day. Excavation measurements are the most difficult to secure daily, but a suggestion as to how this may be done has just been given. The yardage of pavement laid daily is readily ascertained. Since excavation and paving usually constitute the bulk of the cost of a road, it is evident that if a contractor can keep these two items of cost within his bid price, he can usually "win out" on the entire job.

Recording Lost Time Daily.—Lost time is the bottomless pit into which more money has been dumped by road contractors than can be estimated. The author has seen, and has himself experienced, the bitterest disappointment resulting from time lost while wages were going on. It is not an uncommon thing to lay twice as much yardage of concrete on a day entirely free from delays as is laid on the average day. In other words, it seems practicable to do twice as much work daily as actully is averaged. How is this ideal to be attained, or at least approximated? Only by system, and system involves keeping costs in such a manner as to locate definitely and immediately each period of lost time for each gang, and the reason why.

Does the crusher shut down for an hour for repairs? Then the time report for the quarry must show the time of stopping and the time of starting, and the reason for the shutdown. It should be the timekeeper's duty at the end of each week and of each month to summarize all the time losses in the quarry, so that the contractor or his superintendent can see at a glance the size of this loss. Perhaps no better way than this can be invented to demonstrate what extra parts should be kept on hand to minimize delays. Here it may be suggested that whenever a new machine is purchased, the manufacturer should be asked to recommend what and how many spare parts should be carried in stock by the purchaser.

Where the cost of lost time due to breakdowns is kept, it frequently becomes evident that it is economic not merely to have spare parts on hand, but to have entire spare machines. Take a pump, for example, that is delivering water to a concrete mixer and for sprinkling, etc. Upon the service of that one pump will depend the progress of the pavement. Yet to save an investment of $500 to $1,000 in a spare pump, many a road contractor loses several fold that sum each year. Such losses result from failure to keep records that show the cost of lost time.

Daily Overhead Costs.—Closely associated with the question of lost time is the question of overhead costs. Among "overheads" should be included superintendence, office expense, interest and depreciation on plant. Superintendence should include some compensation for the contractor's own time. To the author it seems desirable to divide the contractor's compensation into two parts, (1) salary and (2) profit.

The salary should be only as large as would be paid to a skilled superintendent. The profit should cover both compensation for the contractor's skill as an organizer and financier, plus insurance against all risks for which an insurance policy can not be secured.

A common mistake in estimating "overheads" consists in dividing the annual overhead cost by the number of working days in a year, instead of dividing by the average number of days actually worked. In our northern climates the number of days actually worked by a given organization

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on road construction usually averages about 125, but there are 300 working days in a year; hence a highway contractor and his plant are usually idle nearly 60 per cent of the working days of the year. If a contractor's annual salary as a superintendent be added to the annual salaries of his permanent employes, and if this salary total be divided by 125, instead of by 300, the salary "overheads" per day worked will be ascertained for all practical purposes. Similarly as to plant "overheads" and office rental "overheads."

The total "overheads" per day actually worked must be apportioned among the units of work done. Both highway contractors and engineers who have not been accustomed to prorate overhead costs in this manner will get some surprises. Failure to do this is largely accountable for the fact that so many road contractors "go broke," and it also throws light upon the fact that a good many engineers think that road construction can be done more cheaply by day labor than by contract.

Having estimated the overhead costs per "day worked" (not per working day), some of these daily overheads can be assigned directly to a given class of work. Thus, the daily interest, depreciation and repairs on a concrete mixer can be assigned to the pavement. But certain of the daily overhead costs must be prorated to the different classes of work. There are several theories of prorating joint costs which the author has discussed at some length in the Handbook of Mechanical and Electrical Cost Data. Usually it suffices on construction work to prorate overhead salary costs in proportion to direct labor costs. Thus, if the direct labor cost of grading is $50 a day and the direct labor cost of paving is $100 a day, and there are no other direct labor costs, then one-third of the daily cost of general superintendence and office expense is assigned to grading, and two-thirds to paving. Having assigned all the daily overheads to the different classes of work, divide each assigned total by the number of units of work performed each day worked, to get the unit cost of overheads for each day. It should be noted that by using this method there are no overhead costs for the days on which no work is done, for all the overhead costs are assigned to the days actually worked each year on the average. While there are some objections to this method, it is the only method by which the total unit cost can be estimated with any degree of accuracy for each day worked. And it is highly important to have such an estimate in order to know whether a profit is being made or not. The average road contractor who has a unit cost keeping system usually is deceived into thinking he is making money, because the daily overheads are either not known or are not properly allocated to the various classes of work.

Cost of Installing and Shifting Plant.—There is another source of error in estimating daily or weekly or monthly profits which arises from failure to segregate the cost of installing, shifting and removing the various plant units, together with miscellaneous costs of getting ready to do work. It is rare that any contractor is able to state what these "preparatory costs" have been on any given job, and this holds true even where the contractor has a cost keeping system. No argument is needed to prove that unless the "preparatory costs" are known there is grave danger of underestimating the total unit costs.

Having so kept the daily records as to show the actual cost of moving and installing a crushing plant, for example, to this should be added the estimated cost of shifting it (where shifting will be necessary) and the cost of dismantling and shipping it home. Then this total should be divided by the total number of cubic yards of stone to be crushed on the given job, to get "the unit preparatory and shifting cost" of crushed stone.

This unit cost should be added each day to the "unit overhead cost" and the "unit direct cost" for that day. The resulting total will then be really significant as to what the pavement is actually costing.

Importance of Daily Unit Costs.—It will be noted that the author is contending for the daily and weekly estimating of the total unit cost of each class of units upon which there is a contract price. Unless this is done it almost invariably happens that the road contractor who thinks he has been making a profit on a job awakens toward its close to find that he has actually lost money on it. Now he may lose money on the job even if he does have complete unit costs before him every day, for it is very common to bid so low a price that no profit can possibly be made. But it is surprising what a difference there is in the energy of a desperate man as contrasted with one who is well satisfied. When a contractor realizes that he is daily sinking deeper into the quicksands of bankruptcy, he will usually "camp on his job" night and day, and his wits will be steadily at work. Whereas if he thinks he is making a satisfactory profit, he is apt to take things easy, let well enough alone, go off on frequent pleasure excursions and the like.

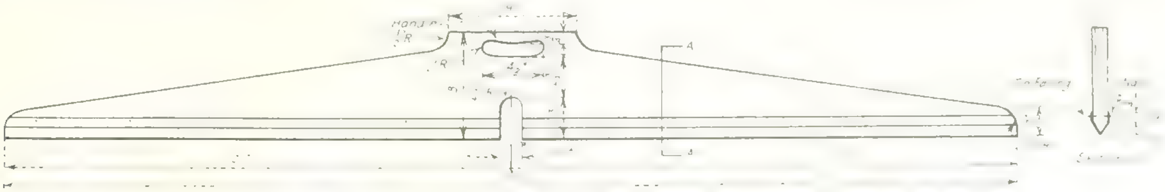
Incidentally it may be remarked that one of the reasons why day labor so frequently exceeds the cost by contract lies in the psychological fact that the engineers and superintendents in charge of the work have no pecuniary stake in the cost of the work.

Summary.—Summing up, a road contractor can use his brains to no better advantage than in finding ways of securing daily reports that show the total unit cost of every item on which he has bid a unit price. To do this it is frequently necessary to invent methods of securing approximately correct estimates of the number of units of work done, and it often pays to employ an engineer for no other purpose than to measure up daily the number of units. Lost time should be reported daily and its cost estimated. Overhead costs should be estimated per average day worked, not per working day, and unit overhead costs estimated every day. Plant, preparatory and shifting costs should be kept apportioned to each class of work, and reduced to unit costs.

If these methods are adopted, profits will be increased or losses decreased. In engineers in charge of contract work will follow the same method, they will usually discover that there is little or no profit to the average road contractor. Indeed unless engineers give adequate study to the costs of lost time, overheads, plant installations, etc., and unless they devise ways of enabling competent contractors to secure adequate prices, it will be only a matter of a few years before there will be no competent contractors in the road building business.

Straight Edge for Testing Concrete Pavement Joints

A joint testing device that is used extensively in Wisconsin concrete pavement construction is shown in the sketch. The device is made from a board 6 ft. x 8 in. x 1⅛ in. The working edge is beveled and faced with tin or galvanized iron. This straight edge is used as a gauge to determine the relative elevation of adjacent slabs by placing the slot over the protruding joint filler immediately after the concrete has been struck off. If there is an excess of concrete on either side of the joint, the straight edge is rocked back and forth and pressed down until the outer ends touch the finished slabs. The concrete so marked is removed and the surface refinished to grade. Insufficiency of concrete, as well as excess, can as easily be detected and corrected. When the straight edge rests on both slabs for its entire length, the work is acceptable. Proper use of this straight edge, it is claimed, insures absolutely that adjacent slabs will be on the same plane. We are indebted to Mr. F. M. Belsey, Division Engineer of the Wisconsin Highway Commission, for the matter in this note.



Gauge for Determining Relative Elevation of Adjacent Slabs

Methods of Contracting for Highway Work During the Reconstruction Period*

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[illegible] efficient method [illegible] period would [illegible] period will pro[illegible] ourselves [illegible] and discussing [illegible] to form a more [illegible] probable results [illegible]

[illegible] contracting for highway [illegible] upon a lump sum bid, based upon unit prices of estimated quantities, the final settlement to be determined as a result of a final survey [illegible] As a rule the preliminary estimate and the final survey closely approximate, rarely is there any material difference. This form of contract has its merits and demerits, every form of contract has, everything in the world has. It was found satisfactory in most cases until the war period.

The contractors who found themselves with work taken at pre-war prices, had two alternatives, one, to abandon their work at the cost of their business existence, and the other alternative to complete the work at a great loss. However well disposed a contractor may have been to have supported his own loss, the resources of many made this impossible, and we see in New York State forfeited contracts totaling on road work alone $5,000,000.

We are now at a point where a contractor will be called upon to hazard another guess as to the future. Engineers' estimates are the basis for the appropriation and in a measure regulate prices. It is the custom for engineers to base their estimates upon prices prevailing at the time the estimate is made, subject to subsequent alteration if any material change occurs between the date of the estimate and the date of the letting. Today, prices have fallen but little from the highest, the matter of unskilled labor—the most important element in road contracting—is certainly undecided. Therefore, the contractor bidding today, if conservative, must base his costs and bid upon the high, both in material and labor. Should there be a material decline between the day of the letting and the finishing of the work, the contractor will profit, just as the contractor lost under the conditions of raising prices after the beginning of the war.

It may be said that we have little occasion to enter into a discussion of this condition, inasmuch as the probalities are strongly against further wars, or abnormal conditions produced by these wars, during this generation. But a similar situation, if not so extreme, may arise from other causes, great scarcity of labor being the principal one, and on which neither the contractor nor the State can make an entirely certain deduction.

But these remarks are made simply as an illustration of how extreme conditions may affect this form of contract. This form of contract is definite, the exact amount to be paid for the work specified is known. Should there be occasion to add to or subtract from the work, we have the unit prices to guide us. The terms are known, and there is little ground left for dispute. That it is a form in almost universal use for all kinds of construction is evidence of its merit.

There are some modifications of this form of contract. One is where the contractor makes an estimate of cost, and agrees to accept a definite fee, usually 10 per cent, the collection of this fee depending upon accuracy of his estimate. Should the cost exceed his estimate, the contractor will lose, up to within 50 per cent of his fee, the amount of this excess. Should the cost be less, the contractor will receive an additional payment of 50 per cent of the saving.

It is customary in some form of lump sum contracts to state the cost price of material and labor used in making the estimate. In this form of contract the state or municipality pays an additional price on a rising market of material and labor, and is credited on a falling market.

[illegible] to be said in favor of both of these [illegible] their earnest advocates.

Another form of contract used at times and in some states and municipalities, but not many, is the "cost plus" contract. Under this the contractor is paid for his time, knowledge and experience a fixed percentage based upon the cost of all the material and labor and rental of machinery that enter upon the completed work. Theoretically this would seem to be a very just form of contract but actually no other form causes as many disputes and as much dissension.

It is a trait of human nature that men will not work with the same vim and energy, will not husband their resources with as much care, will not be as solicitous for the prosecution of the work, where the costs are to be defrayed by the ample resources of the state or the municipality. However conscientious the contractor may be, he is unavoidably affected by this condition, and the men under him will not work for him in his position as quasi-superintendent for the states as well as they will work if they know it is a matter of dollars and cents to the contractor and that his vital interests are concerned. Moreover, this form of contract has only too often led to scandal and adverse criticism, oftentimes unwarranted, but the general public is suspicious of collusion where there are no restraints more than can be prescribed under this form.

States and municipalities expend great sums in doing work under their own supervision. This is the most costly form of doing work that is known, and all records, whether they be state departments or municipal departments, bear out this statement. No doubt it is necessary in small work and in small repairs for the state's forces to be employed, but the policy of engaging in work in a large way and with an expensive equipment is indefensible.

I have now briefly outlined methods of contracting for highway work that have heretofore prevailed. I feel compelled to say that I see no method that will offer an improvement upon the lump sum bid form of contract. It is hazardous to the contractor, it has proved troublesome to the states on the forfeited contract, although in these contracts they receive more than they pay, and it may prove somewhat more than ordinarily expensive on contracts during this period. Quick adjustment will be necessary, but I believe that the officers of the state can protect themselves so that the average will be just.

Perhaps the contractor in this reconstruction period will have more chance of making a large profit than of taking a large loss, but that is not assured, no one can absolutely determine it or the bids to follow would be made in accordance with it. Every contractor knows that his business is a hazardous business. There is a gambling instinct in every man. Those in whom it is most highly developed become contractors. Most of them take losses and gains with a certain equanimity rather bewildering to men engaged in other lines. Every newspaper article that mentions a contractor speaks of him as a "rich contractor." Did you ever know a rich contractor? There may be some, but there are only just about enough to make that exception which proves the rule. And yet, with all the ups and downs, trials, tribulations and hardships, and uncertainties of bidding, I believe that in the reconstruction period and in all other periods, contractors would prefer to take their own chances as to the wisdom of their own judgment and the accuracy of their own figures, estimates, and deductions.

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Excavation, Concrete and Other Items in Wisconsin Road Construction in 1916 and 1917.—The following figures, abstracted from the recently issued 4th biennial report of the Wisconsin Highway Commission, show the quantities of each of the more important items in road construction in the various counties in the year 1916 and 1917:

	1916.	1917.
Excavation, cu. yd.	3,165,236	2,782,177
Concrete in culverts, cu. yd.	25,810	21,377
Permanent surfacings, all types, cu. yd.	3,348,516	3,047,386
Guard rail, lin. ft.	120,844	95,964

Cost of Federal Aid Road Surveys and Plans in Wisconsin.—During the fiscal year ending June 30, 1918, the Wisconsin Highway Commission completed surveys for 404.37 miles of Federal aid road. The average cost per mile, according to the recently issued 4th biennial report of the Commission, was $31.78. During the same period the Commssion completed plans for 249.6 miles of Federal aid road, the average cost per mile being $54.75. The total average cost per mile for the surveys and plans was $86.53.

Conclusions of Wisconsin Highway Commission on Surface Treatment of Macadam

Experiments were conducted in the summer of 1917 by the Wisconsin Highway Commission to determine the best methods of surface treating macadam roads. The experiments are described in the recently issued fourth biennial report of the commission, from which the matter following is abstracted:

The road selected was a section of 9 ft. waterbound macadam between Baraboo and Kilbourn in Sauk county. This road was selected because of several reasons. In the first place it carried a very heavy motor traffic owing to the location of summer resorts on it. Although built in 1913-14 no maintenance whatever had previously been given the road in the way of surface treatment and the surface was in a very rough and uneven condition. In fact some sections should have been entirely rebuilt. Another reason for its selection was that part of the road was built of limestone and a part of quartzite.

In order to compare the various kinds of absorbents on both oil and tar treatments, the road was divided into sections, experiments being duplicated on limestone and quartzite. The selected section was about 2½ miles long and was staked off into 400 ft. sections, each section being located with a post having the section number on it.

The weather conditions during almost the entire experiment were ideal, the weather being bright and warm. The work was done between Aug. 15th and Aug. 22, 1917.

The following absorbents were used: For some sections that were rebuilt a 1½ in. quartzite was used. This stone is of a quartzite formation but not from a quarry, being apparently a glacial drift.

For other rebuilt sections 1½ in. limestone of a comparatively soft nature was used.

½ in. to ¾ in. crushed quartzite was used on some sections.

⅝ in. pea gravel shipped in from Winona, Minn., was used on other sections. This gravel was very uniform, very clean and largely of an igneous nature.

Torpedo sand of a very good quality and very clean was used on still other sections. This sand was shipped from commercial pits at Janesville, Wis.

On other sections a very fine local sand of a very poor quality was used.

The bitumens that were used consisted of Trinidad liquid apshalt and Tarvia B.

There were four units of seven sections each. These units were: 1, quartzite old surface with asphalt as the bitumen; 2, quartzite old surface with tar as the bitumen; 3, limestone old surface with asphalt as the bitumen, and 4, limestone old surface with tar as the bitumen. The sections in each case were as follows:

1. The resurfacing of a piece of road with a new layer of about 2 in. of the large quartzite. This not only covered the 9 in. width of the old road, but reached out about 1½ ft. on each side thus widening the road to about 12 ft. in width. These sections were thoroughly rolled and were given enough bitumen to complete the resurfacing in a satisfactory manner.
2. The same as No. 1 except that large limestone was used instead of the quartzite.
3. Treatment with ⅝ in. pea gravel as an absorbent.
4. Small quartzite was used as an absorbent.
5. Torpedo sand was used as an absorbent.
6. Treatment with an absorbent of fine local sand.
7. Treatment with no absorbent.

All of the bitumen was placed with a power sprayer mounted on a 4-wheel drive truck. The mechanism was so arranged that the quantity of bitumen used was determined entirely by the speed at which the truck was driven. In other words, the amount through the nozzle was constant as the bitumen was forced through by a gasoline engine mounted on the rear of the truck. Therefore the speed of the truck determined the distance over which this constant amount would be spread.

The sections were inspected from time to time but many of them were abandoned owing to the inability of the section to bear the traffic which this road carries. The road has been and is now being taken care of by Sauk county and naturally many of the sections have been abandoned and turned into a better type of treatment than the one given originally.

As a result of these experiments and the observations made on them the Commission's engineers have come to the following conclusions:

That a bituminous layer about 2 in. thick can be successfully placed on an old road with the cold penetration method, and this layer can be made wider than the old road, especially where there has been a certain amount of the original metal brushed off into the shoulders by the traffic.

Where an old macadam road is fairly rough, but uniformly so, not being full of large holes, the larger the absorbents used and the more angular it is, the better will be the surface carpet. In other words, the crushed quartzite and the ⅝ in. pea gravel gave better results than any of the other absorbents, especially on the rough quartzite road.

A fine sand of poor quality is little better than no absorbent at all, except that it prevents the bitumen from being picked up by the passing vehicles.

Where material is being shipped in for an absorbent, it is better to ship in material over ¼ in. rather than under, as some additional metal will then be placed on the highway.

It was found that more care was required in the placing of resurfacing with asphalt than was required with the light tar by the cold penetration method. This is true because where a slight excess of asphalt was used ruts developed, but where a considerable excess of tar was used it merely resulted in deeper penetration and no ruts were formed. This was found to be true, not only on these experiments but on the regular work carried on in various places in the state. However, good results were obtained with the asphalt in many places, but only where great care was used to get only the proper amount of asphalt. It was also found that the tar penetrated a little better and a satisfactory job could be obtained under more adverse conditions than could be obtained with asphalt.

It was found that a more satisfactory surface treatment was obtained where a very light treatment of tar was used on as the first application. This could then be successfully followed by more tar or by an asphalt treatment. It seemed that the tar penetrated much better and provided a better bond for later treatments.

It was found that it did not pay to treat macadam roads that were in very poor and rough condition. Such roads should be reconstructed by scarifying and adding a small amount of new metal before giving them a semi-penetration or surface treatment.

It was found that better results were obtained by leaving the bitumen uncovered for some time before applying the absorbent, especially where sand was used as an absorbent.

$75,000,000 Road Bond Issue in Texas.—The lower house of the Texas legislature on Feb. 26, by a vote of 108 to 19, adopted a resolution submitting an amendment to the constitution to empower the legislature to issue road bonds against the state automobile license funds. It was so amended that the state may protect such a bond issue with a special tax to take care of it in case the automobile fund should be withdrawn. Another amendment was adopted providing that money from such a bond issue shall be apportioned in the counties according to the needs of the state highways. If adopted in the senate the question will be put before the voters Nov. 4 of this year. The resolution provides that the bonds shall not exceed $75,000,000 of the measure

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State Road Board of Rhode Island Asks Change in Highway Laws.—Changes in the highway laws of the state, which will give the State Board of Public Roads the power to determine the width of roads and to acquire private lands for highway purposes, the regulation of motor trucks, and defining state highways, are urgently recommended by the board in its annual report presented Feb. 1 to the legislature. The board further points out that never before have the conditions been so desirable for generous appropriations for road work as at the present time, and it asks for an appropriation of at least $400,000 this year in addition to the income from the automobile department for highway construction. The importance of the appropriation being made early in the session is also emphasized.

Competency of Contractor Deciding Factor in Awarding Highway Contracts*

[illegible]

[illegible]

[illegible] desirable to let [illegible] their ability [illegible] desirable to throw [illegible] of the [illegible] as far as it is possible to do so.

[illegible] capable of [illegible] road work as are the contractors. If this be true, let the engineers exercise [illegible] as carefully [illegible] the benefits ac[illegible] many uncertain factors as possible. A very long step is taken in this direction, and in the direction of making the contract elastic when the state or county furnishes, subject to the contractor's shipping directions, all materials of construction f.o.b. at the unloading point

No state, county or municipality wishes to get its work done for a price so low that a competent contractor must lose money by doing it. On the other hand, no state should be obliged to pay a price so high that a contractor will make an excessive profit on his work. If we can eliminate the uncertainties and make road contracting less of a gambling proposition, if we can secure and retain the services of those who have demonstrated their capabilities, and if we can secure such contractors by paying them a fair competitive price for just the goods that they deliver, why not do it? Is it not better than asking them to gamble, one against the other on an unequal basis? One may be depending on his ability as a contractor, another may be depending on his shrewdness to find some loop hole that will let him out at a profit, another may be depending on his crookedness to pull him through. Yet, when the bids are opened you must accept the lowest bidder or none. He may be one who has never demonstrated any contracting ability, or he may be one who, judging from his reputation, you feel certain will in some manner fail to give you the desired return. You may say that the state is protected by the bondsmen, and that the inspection is up to the engineers, and that the bonus and penalty clause will take care of the time of completion. The answer to these arguments is that experience has proven beyond a doubt that these things can not make a contractor deliver something that he does not possess. Furthermore, the state does not want penalties, nor does it want bondsmen's money. What it does want is the roads. And it wants those roads just as quickly as they can be economically built. The way to get them quickly is to prevent slow contractors from securing contracts. Here, as elsewhere, an ounce of prevention is worth a pound of cure. Don't let such contractors have your contracts.

So much for the contractor who we do not want. What kind of a contractor do we want and what conditions must we provide in order to induce him to enter road work and stay in the business?

The man we want is the one who can build our roads best, quickest, and cheapest. Such a man is entitled to a greater profit than his slower rival for he gives us a greater value, resulting directly from his special ability and his greater efforts. He can do his best work only when he has built up an organization and has plenty of suitable equipment available. In these days of expensive and inefficient labor, his organization and equipment will count for more than ever before: but no contractor can afford to keep idle equipment, nor can he retain his organization unless he has work to keep his best men busy. This means that the state must so arrange the road work that there will be a fairly uniform amount each year. If you plunge in heavily one year and stop operations the next, you will find when you wish to plunge in again that your best contractors have taken work elsewhere or have gone into other lines of contracting.

In order to keep a contractor's organization, or any other organization, efficient, it must have competition—good healthy competition. In this, care must be taken not to handicap good organizations in favor of the poor ones. When one contractor habitually does good work and completes it on time, while another habitually does poor work and requires an extension of time, there certainly is a handicap on the efficient one if he has to bid on the next job on the same basis as the other fellow. They are not bidding on the same proposition at all. Suppose you wanted a suit of clothes. Of two available tailors, one always made good wool suits and delivered them promptly, while the other habitually used shoddy and delivered his suits six weeks late. Would the latter ever get your business at the same price per suit? Certainly not! Why, then, make contractors work on this basis?

A road under construction is of very little value to the traveling public. Often, indeed, it is a decided nuisance. A completed pavement is of immense value to them, otherwise it would not be built. The exact money value per day of any particular completed road over and above its value when under construction is hard to determine. It is safe to say, however, that on the average it would be at least equal to the daily interest on the construction cost, otherwise it would be a poor investment to improve the road.

I wish to emphasize the fact that every day saved in the time of construction is worth real money, and the amount is by no means a small one. Do we fully realize that the interest charges, engineering and inspection charges, insurance charges, overhead charges, and kindred charges will usually amount to over $25 per day? This point has never received anywhere near the attention to which it is entitled.

If, then, we are to have the best contractors go into road building and stay at it, we evidently must take into consideration something besides the low bid when we award our contracts. We must find a clean-cut, honest method of selecting one of the cheapest workers from amongst the best contractors. Then we must pay him as nearly as possible according to his deserts.

A prime requisite in making such a selection is that the method of doing it must have the confidence of the contractors and of the people of the community behind it. It must be based upon something besides opinion. It must rest on something tangible, something that is a matter of record, and something that can be compared. It must be something that can be shown to any dissatisfied bidder that he may see and satisfy himself.

It will not do to leave the selection to the opinion of a board of a commission. Their selection might be perfectly just and honest, but you could not convince a disgruntled bidder of the fact without actually showing him. It is highly important that you do show and convince this man, too, otherwise you may soon cast suspicion on the workings of the sysem and thus destroy its usefulness.

Fortunately, it is not necessary in selecting a contractor that he be absolutely the best one for that particular job. We shall have accomplished our main purpose if only he is one of the best few who might have been chosen. The one thing that is absolutely essential is that all men may know that his salection was honest, and above board, free from politics and favoritism. It is also necessary that the method of making the selection shall be well understood before the bidding. It is highly desirable that the records of the whole proceedings shall be open to public inspection.

To select our contractors approximately on the basis of their relative worth, we must, in some manner, compare them. To compare all the good and bad qualities of contractors, one with another on a definite basis, would be impossible. In too many respects it would be merely a matter of opinion. In one essential particular, however, there need be but little difficulty in comparing them. A contractor enters into agreement to complete certain amounts of work within a specified time after signing the contract. The percentage of this time that he actually takes to complete the work is directly comparable with that of any other contractor on any other road for the same state under the same provisions. He will understand this when he bids, and take into consideration any increase in cost that may result from short-time work.

My idea is that the letting of all road contracts, such as your county roads, should be under the supervision of the State Highway Commission. This commission should decide when a road is completed and keep an accurate record of the per cent of the agreed time actually used on all contracts. This record should be made cumulative for each contractor from year to year, so that its accuracy as an index of a contractor's ability, so far as speed is concerned, is constantly growing. This record should be open to public inspection. It would be used as lettings of contracts to modify each contractor's bid, favoring the speedy ones by a certain definite factor calculated from their past records. The rate and manner of applying this modification would be stated in the advertisement and in the proposal for each road. It would not necessarily be the same for all roads, because speed on an important main road is of more value than on a side road in the country. The amount that the most speedy contractor would be favored by this modification should in no case exceed the value of the time saved, which value we have already discussed. Contractors on their first job for any state would, of course, have no record and would have to be taken at par (i. e., neither favored nor handicapped). This method would in a very few years entirely eliminate the extremely slow incompetent contractors.

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*[illegible] Society of Engi-

By increasing the rate of modification on the important roads, the tendency would always be to concentrate the very fastest contractors on the most important roads where there would be the most profit for them.

Members A. E. F. Favor Better Roads Movement in America

That the present movement for better roads in the United States has the enthusiastic approval of the members of Uncle Sam's forces overseas is the substance of an interesting letter received by Mr. J. A. Sauerman of Sauerman Bros., Chicago, from Major Dwight D. Guilfoil, commanding the First Battalion of the 108th Engineers with the army of occupation in Luxembourg. He writes as follows:

"I sure would have liked to have been in Chicago during that Good Roads Convention. If there is one thing I can talk about now, it is good roads. Also I have quite a flow of language concerning bad roads and no roads at all, having encountered both over here.

"That Illinois bond issue sounds good to me. Really, I believe that you will find an increase in the demands for more road improvements when the army gets back, for there is not a man over here who personally has not experienced the benefits of good roads and the discomforts of bad ones. What is more, it has been brought home to them in such a way that the war side of it will be entirely removed and they will want the good roads purely from an economic view.

"I have built roads out of every conceivable material. There is one little ruined French village that once had a fine large church. This church, together with all the other buildings had been more or less shot to pieces. Mostly more. Today you will find the church and several other buildings are the component parts of a very fine road that I built through that section when our troops advanced. Many and many a time have I thanked whoever is to blame for the fact that nearly all the villages are built of stone. When we arrived at that spot the road had entirely disappeared. Shells and road mines had ripped it to pieces for 1 kilometer and the Boche had flooded the section with 18 in. of water. Three hours after we put over the first horse transport and seven hours after we put over a train of 65 motor trucks. You see, we couldn't wait for material to come up from the rear."

Major Guilfoil was a member of the original Company A, First Battalion of Engineers, Illinois National Guard, which was organized during 1911-1912 by Col. Henry A. Allen and H. B. Sauerman and commanded by the latter from 1912 to 1915. As first lieutenant, Major Guilfoil served with this organization on the Mexican border in 1916, resigning his commission in September of that year to resume his position as sales engineer with Sauerman Bros.

In April, 1917, when the United States declared war on Germany, he was commissioned a captain of engineers and assisted Col. Allen in organizing five additional companies for the 108th Regiment of Engineers. The "108th" landed at Brest, France, in May, 1918, and soon moved forward to the fighting line, performing heroic service in building bridges and constructing roads in the Verdun sector. In October, 1918, Capt. Guilfoil was promoted to major for excellent field service.

Methods of Removing Snow from Highways

A very complete discussion of the problem of keeping highways open for traffic in the winter is contained in a bulletin issued by the Highway Transport Committee of the Council of National Defense. This bulletin, prepared by Raymond Beck, Field Engineer, with A. H. Hinkle, George H. Biles and Charles J. Bennett, collaborators, describes the methods that proved most effective during the winter of 1917-18. The matter following is taken from the bulletin.

How to Prevent Snow from Drifting.

Drifts Do Not Come by Chance.—To solve this problem by preventive methods, it is necessary to begin the study of where drifts usually occur. Snowdrifts do not come by chance. The snow drifts much deeper in some places than other places for a reason. There is always a cause for the drifts and if the cause is removed, the drift will not form. Hence there arises the necessity of observing the location of the bad drifts and their cause, and then attempting to eliminate that cause. Local people can usually furnish information as to the locations.

Causes of Drifts.—The drifting of the snow will take place where the velocity of the wind is checked by some obstruction. The snow is deposited in drifts for the same reason that a sandbar is deposited in a stream where the velocity of the water is reduced, thus allowing the sand or silt which was carried by the swifter moving water to settle to the bottom. It will be observed that in some states the north and south roads are usually drifted much worse than the east and west roads, and in other states the east and west roads receive the heaviest drifts. This is due to the prevailing direction of our winds, together with the fact that the obstructions causing the drifts are usually found paralleling the road. If you have a prevailing westerly wind, an obstruction on the westerly side of a road is many times more objectionable than on the east side. Upon investigation it will frequently be found that snowdrifts in the road have been caused by a fence along the road. Rail, board, picket, and especially hedges fences, are very common causes of snowdrifts in the road. They check the current of air long enough to cause a drift to form. Mills or high banks, where there are cuts in the road, will frequently be sources of drifting snow. Brush rows along the road will invariably cause drifts to form. Even a few weeds, although innocent looking, may check the current of air sufficiently to cause it to deposit its load of snow.

A row of weeds along the immediate road shoulder may be the source of considerable annoyance by causing snow to drift on a road which is well above the surrounding country.

The distance of a hedge or fence from the road determines whether it acts as a cause for snowdrifts or if sufficient distance away, as a drift preventive. If close to the road, a hedge with vertical sides is a better drift-former than one with sloping sides.

In snowing, the wind eddies with horizontal axes are the chief drift-formers. Those with vertical axes are potent snow-carriers. A hedge with level top will form immediate drifts quicker than a hedge with broken or uneven top. If there is a foot or more variation of level at the top of hedge every 20 or 30 in., this will cause the formation of eddies with vertical or much-inclined axes. These eddies do not beat the snow into a drift, and longitudinal transference within them results in their being held in the air until they get across the road.

Remove the Obstructions Which Cause the Drifts to Form.—It is readily seen from what is given above, that a method of preventing the snow from drifting would be to remove the obstructions which check the current of wind. This can be done. Low bushy trees can be trimmed. A tree trimmed some distance from the ground will ordinarily not be a serious source of drifting snow on the highway. Fences of the type mentioned above should not be constructed along the highway. We cannot always in justice to the farmer tear down a good fence; but we can discourage the use of such fences along a highway as will be a source of future trouble in causing snow to drift. However, the seriousness of the case will frequently justify the removal of certain fences. A wire fence will not cause the snow to drift because it offers little or no obstruction to the wind. A hedge,

[illegible]

Use of Snow Fence. Of course we will not be able to re[illegible] a hill where it is the cause of drifting snow, but there [illegible] r means of prevention which may be used in this [illegible] Since it is an obstruction that causes drifts to form, [illegible] ance from the highway, it would be a relief by causing [illegible] highway. Hence, by the construction of some obstruction (let us call [illegible] from the highway we many largely prevent the drift from forming on the road.

[illegible] can be used to advantage. Instead of using stakes to anchor the fence to the ground, a board may be nailed to the bottom of the two legs to hold the fence erect. When this is done, [illegible] of the fence to the ground in order to make it sufficiently stable to prevent if from blowing over. A picket fence with pickets placed closely together may be temporarily erected for this purpose. It is readily removed, as it can be detached [illegible] in the spring and laid away until the next winter. The picket fence may be fastened to posts driven into the ground. One and one-half inch hollow iron posts or $1^3/_4$-in. x $1^3/_4$-in. x3/16-in. iron or 3-in. to 4-in locust posts may be used for this purpose. The posts can be easily pulled in the spring of the year when the ground is soft. A portable fence would be used where it is necessary to remove the fence during the summer so the fields could be cultivated, or for other causes.

Stationary Snow Fence.—A stationary snow fence might be made by spacing 6-in. boards, 2 to 3 in. apart on posts set vertically in the ground to a height of about 6 ft. above the surface. However, where the land is under cultivation, it would not be practical to use a stationary fence. In such places, if a snow fence is used at all, one of the portable designs would have to be adopted.

Location of Fence.—It sould be observed that the proper location for a snow fence is some distance back from the edge of the highway. This distance will vary according to the height of the fence. The distance from the edge of the road would be 8 to 10 ft. per foot of height of the fence.

Owing to the expense of constructing a snow fence and the erecting and removing of it every year, the preventive methods previously described should be resorted to wherever possible, before resorting to the use of snow fences. It may not be practical to use a snow fence except in extreme cases where the snow drifts badly every year onto very important roads.

Study the Causes of Drifts.—A careful study of the causes of drifting snow at any particular place will be of great value in solving the problem. It must be kept in mind that the direction from which the wind comes is a determining factor in the location of the drifts. However, inasmuch as the majority of our winds are from a westerly direction, the location of drifts will frequently be in the same place.

How to Deal with the Snowdrifts and a Heavy Fall of Snow.—Two methods of dealing with the snow problem, when the snow cannot be prevented from drifting onto the road, present themselves: (a) Compacting Method; (b) Removal Method. On secondary roads that drift badly, it is customary in places to drive across the fields in order to avoid the drifts in the road. However, because of fences and objections to trespassing on private property, this practice can be followed only in certain places even on secondary roads, and the custom would never be practical on heavily traveled roads. Hence, the present road must be made [illegible]

[illegible] solving the problem of a heavy fall of snow on a country road is to uniformly compact it by the use of a roller. A roller 5 to 6 ft. in diameter and 10 to 12 ft. long is perhaps best suited for this purpose. The roller should have closed ends in order that it can be pulled most easily over the snow. The rolling should be done when the first fall of snow comes and when the layer of loose snow is not more than 8 in. to 10 in. deep. As more snow falls, or "blows" come, causing the snow to drift, the rolling can be repeated as many times as is necessary. The object sought is to compact the snow sufficiently hard to carry the traffic thereon. With continued snows and rolling, this process will "build up" the surface to such a height that the snow will drift less thereafter on the traveled roadway. This can only be recommended, however, for extreme northern sections. It is important that the rolling be done over a sufficient width that vehicles can readily pass without getting off into the loose snow.

Snow Removed by Road Grader.—An ordinary road grader is an excellent machine for scraping the snow from the road surface. Iron shoes placed under the grader blade to prevent it from gouging into the pavement or catching on some slight projection are sometimes used. A heavy road grader is desirable in order that it will not be shifted sidewise by the snow. Three, four or six horses may be used to pull the grader as the depth of snow and weight of grader will demand.

A-Shaped Snowplow.—An A-shaped snowplow is sometimes used for opening a track in the road. This can sometimes be used where the depth of snow is too great to use a road grader. It will of course be necessary to use enough horsepower to readily pull the plow through the deep snow. In order that the plow will travel in a straight line down the road, the length of the hitch should be as short as can be conveniently made. The plow can be made to vary in weight as the conditions of the snow will warrant.

Snowplow Attached to Front of Motor Truck.—A snow plow attached to the front of a motor truck has been used to a considerable extent in removing snow from the road. It cannot be made to operate in deep snow as is the case with the road grader; however, it has a big advantage in being speedy and can be used to keep the road clear while the snow is falling. These snowplows are attached in front of an ordinary motor truck and have been used with most excellent results.

The use of a power-driven rotary sweeper similar to that used by electric railways to clean their tracks, or the use of a side elevator machine for opening up large drifts would seem to be a possibility. Owing to the fact that there is a greater demand each year for cleaning the road of snow it is possible that some such machinery will be developed for this purpose in the future.

Hand Methods.—Where heavy drifts have formed, it may be necessary to clear the road by "Hand Methods." Large shovels should be used for this purpose. Inasmuch as the hand method of clearing the road is very expensive, machines described above should be used wherever and whenever possible. By continually operating the machines mentioned above during a storm, hand methods can be largely avoided. Where this can not be done, or where it is not done in time to prevent drifts, openings, through the snowdrifts will have to be shoveled out by hand.

Width to Be Cleared.—The width of road to be cleared of snow will depend upon the kind and amount of traffic to be accommodated. Ordinary farm traffic consisting of horse-drawn vehicles and light pleasure motor cars will be accommodated by a minimum clearance of 6 ft., while the heavy motor trucks will require a width of not less than 8 ft. For this latter kind of traffic, even through high snow banks, it is desirable to make a clearance of not less than 9 ft. A double track width, even in high drifts where the drift is continuous, should be cleared at intervals to permit vehicles to pass. The amount of traffic on main thoroughfares will usually warrant the clearing of the pavemuent to its full width. Clearing the surface of snow for its full width will also frequently be a saving in the maintenance of the highway by reducing the tracking of vehicles which is very destructive to certain types of pavement.

When starting first to clear the road of snow by the use of machines, it is very necessary to scrape the snow farther back than is really necessary for the time being in order to have room for the snow to be removed on successive cleanings. This, of course, would apply more especially where the snow is removed with a snowplow or road grader rather than where it is shoveled out through large drifts.

In scraping and shoveling snow from the road it is very desirable that the removed snow, so far as possible, be piled on the opposite side of the road from the prevailing direction of the wind, in order to reduce future drifting on the highway.

In the first operations of scraping the snow from the highway by the use of a road grader, or a snow plow attached to the front of a truck, it may be more economical when later work is considered, to scrape the snow in but one direction in order to reduce future drifting on the highway. It must be remembered that a pile of snow will cause a drift to form on its lee side just as much as will the other obstructions described under "Causes of Drifts."

Depth to Be Cleared.—On improved roads every effort should be made to remove the snow within a few inches of the surface of the road, so that no opportunity can be given the traffic to track. If traffic is permitted to track during periods of freezing and thawing on such highways, the road surface itself becomes affected to various degrees depending on the type of road. Conclusive analyses show that snow clearance will make effective the longer life of the improved road.

Drainage.—Especial attention should be given to drainage. Cuts should be made through banks of snow to ditch lines at certain intervals where possible, and drains and culverts kept open and free from obstruction. This precautionary measure will produce good results, for when the snow passes away in the spring, the roads will come through the winter in better shape, in spite of the fact that they have been subjected to greater traffic.

Iowa Road and Bridge Work

Iowa, with a total road mileage of 104,082, spent $14,195,753 in 1918 on roads and bridges, according to the Service Bulletin of the Iowa Highway Commission. This expenditure was $1,069,723 less than that of the previous year. Of the total $10,664,870 was expended by counties on roads and bridges and the remainder was township road expenditures. A comparison of the percentage of money spent on permanent work since 1914 shows the following:

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Bridges and culverts	[illegible]	[illegible]	[illegible]	65.1	[illegible]

The percentage of engineering cost of the work for the five years follows:

	1914.	1915.	1916.	1917.	1918.
County engineering	[illegible]	2	[illegible]	[illegible]	[illegible]
Highway commission	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

The average expenditures per mile were:

	1915.	1916.	1917.	1918.
County roads	[illegible]	[illegible]	[illegible]	[illegible]
Township roads	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Average total expenditures per mile roads and bridges (104,082 miles)..	130.00	138.00	145.00	135.43

Table I summarizes the average cost of road work for the past four years:

[illegible]	1915.		1916.		[illegible]		1918.	
	[illegible]	[illegible]	Mi.	[illegible]	Mi.	Average cost per mi.	Mi.	[illegible] per mi.
Roads constructed to permanent grade ...	462.7	$1,356	625.2	$1,251	[illegible]	$1,048	[illegible]	$1,633.11
Roads constructed to temporary grade ...	355.9	682	108	927	40.60	1,733	29.51	1,770.54
Roads constructed to natural grade (traction [illegible]) .	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	154	[illegible]	
Roads surfaced with gravel	182.0	125	[illegible]	[illegible]	[illegible]	1,108	335.52	1,003.38
Roads paved [illegible]						2,823	7.87	31,822.[illegible]
Roads dragged [illegible]	[illegible]		[illegible]	[illegible]	15,724.00	[illegible]	15,766	31.02

New Government Bulletin Discusses Drainage Methods and Foundations for County Roads.—The first essential feature of an improved road is adequate drainage, and another prime requirement, wherever a hard surface road is to be constructed, is a firm foundation. These facts are emphasized in Bulletin 724, "Drainage Methods and Foundations for County Roads," just issued as a professional paper by the Bureau of Public Roads, United States Department of Agriculture. The purpose of the bulletin is to supply information concerning the proper methods of draining roadbeds constructed of various kinds of soil, and under different topographical conditions, and also to explain how foundations may be designated to suit the soil conditions, the road surface and the system of drainage. Some of the topics treated in the bulletin are primary soils, drainage design of surface drainage, gutters, drop inlets and catch basins, sub-drainage foundations and specifications.

Present Status of Federal Aid Road Projects

[illegible] of the U. S. Bureau of Public Roads under the Federal Aid Road Act were described by Mr. P. St. J. Wilson, Chief Engineer of the Bureau, in a paper presented Feb. 25 at the 16th annual convention of the American Road Builders' Association. In his paper Mr. Wilson gives the following information regarding the present status of the projects:

At the close of Feb. 21, 1919, a total of 841 projects had been approved by the Secretary of Agriculture, involving a total estimated cost of $61,333,455, of which Federal aid was called for to the amount of $23,203,112. These projects aggregate 8,615 miles in total length, and involve every recognized type of construction, this being due to the policy of trying to meet the individual needs in the light of the local conditions in each state and locality.

Of the total number of projects approved 434 had reached the stage at the close of Feb. 21 where the plans, specifications, and estimates had been approved so that construction might actually begin. These projects carried a total estimated cost of $30,111,227, of which amount $11,663,087 consisted of Federail aid. The total mileage of the projects thus made ready for construction was 3,586 miles. On Jan. 31, 316 projects were actually under construction or completed, involving a total estimated cost of $22,672,233 and Federal aid to the amount of $8,382,067.

The total amounts apportioned to the several states after deducting 3 per cent for administrative purposes aggregate $29,100,000 for the fiscal years 1917, 1918 and 1919, this period ending June 30 of this year. An additional $19,400,000 becomes available July 1, making the total apportionment for the four years $48,500,000. Deduct from this the amount of approximately $8,500,000 referred to above and we may say there are $40,000,000 of Federal funds to apply to this year's projects. As the states must provide at least an equal amount, there will be a minimum of $80,000,000 for Federal projects if all of the Federal money under existing appropriations is met. As a matter of fact the states have been putting up in the past a little over 60 per cent of the cost of Federal projects and if this policy continues, the amount available for Federal aid roads would run over $100,000,000. To this amount must be added the Forest Road appropriations which are averaging about $1,300,000 per annum of Federal funds, making available for this class of work, including local funds, approximately $2,600,000.

The amendment to the Post Office bill carries an appropriation of $50,000,000 to become immediately available, $75,000,000 to become available July 1 of this year, and $75,000,000 to become available July 1, 1920. Thus, it provides for this calendar year an additional $125,000,000 and if this is met dollar for dollar by the states, it means $250,000,000 added to the $80,000,000 already mentioned, or a total of $380,000,000, including administration. The forest road appropriation under the new amendment is $3,000,000 for the fiscal year 1919, and $3,000,000 for each of the following fiscal years, so that it would mean an additional $6,000,000 for forest roads this year.

Lien Law for Engineering Fees Proposed.—The Florida Engineering Society expects to request the Florida Legislature which meets next April, for legislation on two matters of engineering interest—a boiler inspection law, and a law to make engineering fees a labor lien on the property concerned. The boiler inspection law will be as nearly as possible the same as that recommended by the American Uniform Boiler Law Society, and is a measure needed for the welfare of the general public, in view of the frequency of boiler explosions in the state. The law about engineering fees will be more particularly for the benefit of the profession as distinguished from the general public.

Road Grading with Blade Grader-Tractor Outfit

[illegible]

[illegible] should be determined by setting a long pole at the top of the hill [illegible] will be and then lining in shorter stakes between the ends [illegible] apart as circumstances warrant. The ditch line should then [illegible] proper distance from [illegible] on the ditch line should not be over 100 ft. apart. The cuts and fills are small and it is not necessary to set slope stakes.

[illegible] has been done on the sides to widen out the road, and the ground is left in an uneven condition it is necessary to plow a furrow at the ditch line following the stakes that have been set. It is absolutely necessary that this furrow be straight if you expect to get a clean-cut job, and where the ground is very [illegible] to have a man lead the team while plowing this furrow. Where the ground is fairly even it is not necessary to plow; a good grader operator [illegible] the stakes as a guide. In making the first cut the grader blade should be set so that the grader will cut like a plow, keeping the heel of the blade about as high as you can get it.

The final appearance of the road and its cost depends upon the grader operator. The best man that can be obtained is none too good; he should have a good eye and be familiar not only with the operation of the grader but the engine. Most operators try to do too much, especially with the first cut. The most successful operators take a light cut first, keeping the heel of the blade rather high; in other words, they shave off the sod, cutting it as thin as possible. When the first cut is carried to the shoulders in this manner what sod has not been lost in stump holes and uneven places in the road is ground and mixed with earth by the combined action of the grader and tractor. A good operator not only watches the ground ahead and shifts his blade accordingly, but he also watches the engine so as not to overload it. This factor is somewhat obviated where a large sized tractor is used.

Tractor and Graders on Wisconsin Road Work.

Mr. Mengel is of the opinion that much time is lost if anything less than a 30-H.P. engine is used; time is lost pulling out of bad places, the operator is unable to cut off the high points while taking the regular cut, and a tractor will [illegible] 75 per cent capacity using the reserve power for emergencies. The 10-ft. blade grader will work very well with the above described tractor; it is not too light nor too heavy, it has a long wheel base and will move a large amount of earth if properly handled.

The best time to make the necessary cuts and fills is after the second or third round has been completed and the loose dirt and sod, if there is any, has been moved to the shoulders. Wheel scrapers or fresnos can be used to move the loose dirt, to make the necessary fills and help true up the cross section. Three to five teams can be used to advantage to do this work.

The tractor and grader are of course always on the move, and it has been found that when 8 to 14 round trips have been made with three to five teams working all the time, a very satisfactory roadbed will be secured at a minimum cost. The tractor outfit moves a little faster than 1 mile per hour. Under good working conditions, if the outfit does not have to stop for repairs, a crew of this kind will grade a mile in three days.

Tractor Hauling Scarifier on State Road Work.

The Wisconsin Commission has found that light soils can be graded with a heavy grader and tractor to advantage, wherever there is any vegetation growing at the side of the road and there is some humus in the soil. In work on soils of this character it has been found that it is best to start the first cut just outside of the shoulder and bring the good dirt to the center, and make the next cuts farther out toward the ditch line, finally out to the ditch line. The cut at the ditch line should never be more than 3 or 4 in. deeper than the good soil. In this way all of the good dirt on the road is brought to the center of the road, the crown of the road being nearly flat. It is found that the combined rolling and mixing action of the tractor and grader mixing all of the dirt and packing it down will make a very good road after a few rains if the road is reshaped and dragged when it is fairly wet. It is possible to grade in this manner many sandy roads and get a satisfactory surface, which if graded under the old system would have to be surfaced.

Method of "Ironing Out" Asphalt Carpet Treatment.—Unevenness of road surface on a highway in the Queen Victoria Niagara Falls Park, due to creeping and buckling of an asphalt carpet treatment on the macadam was remedied as follows: After a number of experiments, kerosene oil was used to soften the asphalt so that the uneven portions might be scraped true to grade with an ordinary road scraper. The softened surface was then thoroughly rolled at an angle of 45° with the axis of the roadway, and a light coating of sand was applied to cover the oil. Care had to be exercised in the rolling, because too much made the surface brittle and destroyed the bond between the asphalt and the stone. The results, states Mr. John H. Jackson, Superintendent of the Park in his last annual report, were fairly satisfactory and the roadway was much improved.

Public Service Commission Asks Lower Rates on Construction Material.—The Indiana Public Service Commission has suggested to the federal railroad administration that the administration reduce freight rates on brick, stone, gravel and other bulky building material to ½ ct. a ton a mile with a minmum of 15 ct. a ton. The suggestion is made in the interest of stimulating building and other new construction work now deemed so necessary to avoid an unemployed labor situation.

Efficiency of Bituminous Surfaces and Pavements Under Motor Truck Traffic*

By PRÉVOST HUBBARD,

Chemical Engineer, U. S. Bureau of Public Roads.

The title of this paper covers a subject upon which a great deal of thought has been spent by progressive highway engineers as applied to pre-war traffic conditions and its progressive normal development. Many engineers had, at least in their own minds, classified the various types of pavements with relation to their efficiency under ordinary variations in traffic encountered on county, state and municipal highways and their ideas were fairly well fixed on the subject as evidenced by more or less consistent practice in their choice of types when reconstruction or new construction became necessary. Just where the dividing line should be drawn, so far as traffic is concerned, between different types of pavements has always been a matter of individual opinion, but in general with increases in volume and weight of traffic the increasing efficiency of the bituminous types has been rated as follows:

1. Bituminous Surfaces.
2. Bituminous Macadam.
3. Bituminous Concrete.
4. Sheet Asphalt and Asphalt Block.

The Situation in 1918.—Suddenly and with little opportunity for anticipation, a very large mileage of our important state highways and many of our local county and municipal pavements were subjected to a tremendous increase in traffic. This increase was not only in volume, which would have presented a comparatively simple problem to solve, but in the weight and load carrying capacity of the individual vehicle. This, coupled with an unusually severe winter and immediately followed by war restrictions upon the use of many road materials, labor shortage, excessive costs, and loss of members of highway engineering organizations, created a situation during the year 1918 which was abnormally serious and complicated. With comparatively few exceptions, new construction ceased and maintenance was so handicapped as to become inadequate.

Hundreds of miles of roads failed under the heavy motor truck traffic within a comparatively few weeks or months. Roads with bituminous surfaces, bituminous macadam roads and bituminous concrete roads all failed alike, together with other types used in state and county work. These failures were not only sudden but complete, and almost over night an excellent surface might become impassable. Such rapid and complete failures in municipal pavements were of less common occurrence and as sheet asphalt and asphalt block have always been largely confined to municipal work, failures of these types have not been noted to the same extent as the other types mentioned.

Outstanding Feature of Road Failures Under Heavy Motor Truck Traffic.—In the haste and confusion of war activities little opportunity has existed for a systematic and comprehensive study of the problem suddenly thrust upon highway engineers. Reports from all parts of the country have, however, established one outstanding fact which has a most important bearing upon any consideration of the efficiency of bituminous surfaces and bituminous pavements. A very large proportion of the failures have been characterized by an almost simultaneous destruction of the entire road structure, and not merely the disintegration of the wearing course or pavement proper. No type of pavement will be efficient unless provided with a foundation which will hold up the pavement until it is worn out. When, therefore, the entire structure fails suddenly, inadequate subgrade or foundation conditions are primarily responsible and but little basis exists for placing an efficiency valuation upon the wearing course.

Subgrade and Foundation Conditions.—Inevitably coupled with subgrade and drainage conditions, foundation failures occurring as previously described may be due to one of two causes, lack of thickness, or inability of the foundation structure to sustain the loads without appreciable internal movement. So far as bituminous surfaces or bituminous pavements are concerned, remedy of the first cause does not affect the general type of construction. If, however, present heavy motor truck traffic is to continue and possibly increase in weight as well as volume the second cause may have a direct bearing upon possible modifications in design and in the ultimate determination of the efficiency of certain classes of bituminous work. Most subgrades have a much lower carrying capacity in the spring than at other periods of the year. As there is practically no slab effect produced by the structure of a broken stone or gravel foundation a load applied to any overlying bituminous surface is trasmitted quite directly to the subgrade. In other words, the intensity of load under its point of application is relatively high throughout the foundation thickness. Under heavy motor truck traffic the intensity of load transmitted through a 2-in. thickness of dense bituminous concrete to the foundation may be so great as to cause an internal movement sufficient to produce disintegration of the pavement. This is particularly true when the subgrade is of a soft or clayey nature and appears to be quite possible irrespective of any economical thickness of broken stone or gravel foundation which may be used. In general, the experience on heavily traveled city streets has demonstrated the necessity of a slab foundation for any wearing course and there appears to be no reason why such experience should not serve as a guide for new construction of bituminous pavements on state and county highways subjected to modern heavy truck traffic. On these highways the traffic has certainly been as severe as on many city business streets, so far as weight of unit loads is concerned, and more severe when the high speed often attained by such traffic is considered.

Surface Treatments for Gravel and Macadam Roads.—With respect to existing gravel and macadam roads, whether or not they have been previously surface treated with bituminous material, it would seem far safer at the present time to attempt to preserve such roads under heavy motor truck traffic by means of surface treatment with bituminous materials rather than to utilize them as foundations for the construction of new bituminous macadam or bituminous concrete pavements. In other words, for the time being such treatments may prove more efficient than the use of a higher type of pavement placed upon the existing road, although it is clearly recognized that, under heavy motor truck traffic, the bituminous pavements are more efficient providing the foundation is adequate to support the loads.

Under the same conditions of traffic bituminous surfaces are most efficient in localities where frost action is either absent or not severe. Such treatments used in connection with gravel roads adjacent to army cantonments in the far South have given reasonable satisfaction even under heavy motor truck traffic. North of the frost line and particularly in connection with the treatment of clayey gravel roads which become soft during the spring months, bituminous surfaces are apt to completely disappear. If, however, the gravel road is maintained by dragging and at the end of the thawing-out period is reshaped, thoroughly compacted and again treated with bituminous material, it may be kept in a reasonably satisfactory condition. Under very heavy motor truck traffic, however, maintenance costs may be extremely high so that if a continuation of such traffic is to be expected the construction of a new road may be necessary. Thus, during a period of 120 days on a clay gravel road leading from Alexandria to Camp Humphreys, Virginia, which was subjected to an average daily traffic of some 230 heavy motor trucks, the cost for maintenance amounted to approximately $10,000 per mile. Because of this enormous expense the construction of a new type of road became necessary.

In connection with this road it is of interest to note that prior to its maintenance as a gravel road, it had served as a 6-in. foundation for a dense bituminous concrete pavement 2 in. thick. This pavement had successfully passed a year of ordinary country and pleasure traffic carrying a large number of touring cars between Washington and Mt. Vernon. In the spring of 1918, it was suddenly subjected to an average traffic of over 200 heavy motor trucks a day and within a comparatively few weeks was absolutely ruined, due to failure of the foundation during the thawing out period. An extension of this road in the city of Alexandria consists of a number of sections of very carefully constructed bituminous macadam laid some years ago upon a concrete base. Although subjected to the same heavy

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*Paper presented Feb. 25 at the 16th Annual Convention of the American Road Builders' Association.

[illegible] in a [illegible] laid [illegible] condi[illegible]

[illegible] Method of Preserving [illegible] may prove the [illegible] the existing road until money is available for reconstruction. It is [illegible] main-[illegible] throughout the year.

[illegible] of expert [illegible] Pike, Mary-[illegible] that such surfaces constructed with suitable tar and oil products are [illegible] provided the patrol [illegible]. If such a system had [illegible] when from 28 traffic counts an average of 135 motor drays, 816 motor pleasure vehicles, and 61 horse-drawn vehicles per day passed over the road, it would from all indications have been completely destroyed.

Efficiency of Bituminous Macadam Under Heavy Traffic.

[illegible] of bituminous macadam under heavy motor truck traffic, there are a number of points to be considered. In general, bituminous macadam has not been thought to be efficient for such traffic but, on the other hand, it has almost invariably been placed upon a broken stone or gravel base. Results obtained in the city of Alexandria, which have previously been mentioned, indicate that if properly constructed and laid upon a concrete base the bituminous macadam may prove quite satisfactory.

Aside from character of foundation, it is believed that sufficient attention has not in general been paid to the important details of bituminous macadam construction so as to obtain best results. Too frequently the coarse stone is not sufficiently compacted before the first application of bituminous material is made and later uniform compaction is extremely difficult, if not impossible to secure. Rutting the road with certain types of distributors just prior to application of the material is a common cause of lack of uniformity in competition, and a strong tendency to distribute faster than the road can be satisfactorily compacted and finished by a single roller is another. Best results from this type of road which have come under the writer's notice have been secured by the hand-pouring method, although this method is considered antiquated by many engineers. Where the first application upon the thoroughly compacted coarse stone is made diagonally across the center line of the road and the second pouring or seal coat is made in a direction diagonally across the first, with proper attention to uniformity of distribution it is possible to secure a very excellent pavement, as has been repeatedly demonstrated by Mr. E. C. Dunn, City Engineer of Alexandria, Va.

The efficiency of bituminous concrete, sheet asphalt and asphalt block pavements under city traffic is so well understood as to require little comment in this paper. If laid upon suitable concrete foundations there is no reason to suppose that the results given by these pavements in city construction will not be duplicated on county and state highways subjected to heavy motor truck traffic. If the foundation is inadequate to support the load, the pavement is bound to fail but, as previously pointed out, failure cannot then be considered a measure of efficiency of the pavement proper.

Bituminous Materials and Their Use.—With regard to materials of construction a few comments may not be out of place, as the efficiency of a bituminous surface or bituminous pavement depends not only upon its method of construction but of what materials it is composed.

In general, the author's observation and experience has been that the most efficient bituminous carpets are constructed with the heaviest grade of bituminous material which it is possible to apply and make adhere uniformly to the road surface. For cold surface treatment this will demand either a cut-back asphalt, a heavy asphaltic oil with specific viscosity of 80 to 120 at 25° C. containing an appreciable amount of volatile material that will evaporate after application and leave practically an asphalt mat residue, or the most viscous refined tar product that can be applied cold. For the latter a specific viscosity as high as 25 to 35 at 40° C. should be used if climatic conditions will permit. While on old macadam roads it is advisable to keep the thickness of carpet under ½ in., on certain types of soft gravel it may be of greater thickness provided a hard and tough coarse aggregate cover of sufficient size to force into the old gravel surface by rolling is used. For clay-gravel or sand-clay-gravel roads north of the frost line it is believed that for maintenance under heavy truck traffic light superficial treatment with bituminous materials applied cold will prove more efficient than the construction of a bituminous carpet, although neither will be adequate to carry the road through winter.

With regard to bituminous macadam and coarse aggregate bituminous concrete, there is little to suggest in connection with the grades of bituminous materials ordinarily used. It is believed, however, that even in the northern United States the use of an asphalt cement softer than 120 penetration or a refined tar of less than 120 seconds float test at 50° C. for bituminous macadam is inadvisable if modern heavy motor traffic is to be sustained. It is also believed that more attention should be given to specifying and securing a uniform size, and grading within reasonable limits, of coarse stone for bituminous macadam in order to promote uniformity in the penetration of the bituminous material as it is applied and to produce a surface that will wear as uniformly as possible. Such specifications should be based upon tests made with laboratory screens and should at least cover the permissible percentage retained on the maximum and passing the minimum diameter of screens selected, as well as the percentage limits required to pass or be retained upon an intermediate screen.

In connection with sheet asphalt and the fine aggregate bituminous concretes the tendency to use harder grades of asphalt cement than heretofore used may prove advisable for very heavy traffic conditions. It is quite possible, however, that better results may be secured by a reduction in the compacted thickness of such pavements with a corresponding increase in thickness of binder courses where one is commonly used. For fine aggregate bituminous concretes which are commonly laid without a binder course, the introduction of such a course not less than 1½ in. thick may prove advisable with a reduction in thickness of wearing course to not more than 1½ in. Provided the binder course is properly constructed such practice should tend to produce a pavement less susceptible to displacement under heavy motor truck traffic. In any event it is believed that even more attention should be paid to aggregate grading than heretofore in order to produce most satisfactory results.

The resistance to displacement of compacted bituminous aggregates, containing particles from ½ in. in diameter down and consisting largely of sand, is mainly dependent upon grading of the mineral aggregate and hardness of the bituminous cement. When, however, the particles become very small and possess absorptive or colloidal properties neither grading nor consistency of the cementing medium are such important considerations. Very large surface contact and high frictional resistance then becomes the prime factors. Thus, a fine mastic composed of limestone dust or clay and a very soft asphalt cement may exhibit even greater resistance to displacement than a graded sand aggregate mixed with much harder asphalt cement. The former type is exemplified by certain finely pulverized bituminous limestones. Use of the latter has but recently passed the experimental stage. It is quite possible, however, that future developments will establish such extremely fine bituminous aggregates as being highly efficient under heavy motor truck traffic for both the sheet and block type of construction.

$32,000,000 River and Harbor Bill Passed.—Enactment of the $32,000,000 rivers and harbors appropriation bill providing for 75 new projects was completed Feb. 26 with the adoption of the conference report in the senate without a record vote. The measure now goes to the president.

Results and Lessons from First Year of State Highway Maintenance in Wisconsin

In 1918 the Wisconsin Highway Commission began maintaining 5,000 miles of state truck highway by the patrol system, supplemented in a majority of counties by gang maintenance, the latter work being performed by small gangs doing heavy blade grader work, scarifying gravel or macadam roads and reshaping them, resurfacing gravel or stone macadam roads, applying surface treatments, etc. The results obtained and the lessons learned from this first year of state maintenance are outlined by Mr. J. T. Donaghey, Maintenance Engineer of the Commission, in the recently issued report of the Commission, to which we are indebted for the matter that follows.

Conditions of System May 1, 1918.—As early in the spring of 1918 as weather conditions permitted, the Commission's division engineers made a condition survey of the entire trunk system, showing by miles and tenths of miles the type of road and its condition. Changes in type and condition are shown on a progress chart in the main office as reported from time to time by the division engineers. This survey showed the 5,000 miles divided as follows:

	Miles good	Miles poor
Earth roads	[illegible]	[illegible]
Gravel roads	1,001	[illegible]
Macadam roads	573	102
Concrete roads	118	3
Other high type roads	[illegible]	
	[illegible]	[illegible]

Roads placed in the "good class" were those that could be maintained in a satisfactory condition by ordinary patrol maintenance methods. Those in the "poor class" required heavy blade grader work, drainage, resurfacing, or scarifying before the patrolman could maintain them in a satisfactory manner.

The survey showed 9,904 culverts on the system, of which 1,164 were wood, 1,050 stone, 3,550 steel, and 4,140 concrete. It also showed 2,568 bridges on the system, 324 of which were wood, 199 stone, 1,035 steel, and 393 concrete.

Results Obtained.—The aim was to get as many miles of the poor converted into good during the season of 1918 as was possible, as it was appreciated full well that the patrolmen would gradually change the good to excellent, but could not materially change the poor to good without help.

At the close of the maintenance season, Dec. 1, 1918, the following improvement of the System had been accomplished by gang maintenance: Heavy blade grader work, 625 miles; scarifying and reshaping stone and gravel surfaces, 150 miles; resurfacing stone and gravel, 135 miles; placing a temporary surface of clay or gravel, 100 miles; covering bad sandy sections with hay or straw, 20 miles; bituminous surface treated, 250 miles; covering badly worn macadam roads with a light application of sand or loam, 25 miles.

The gang maintenance work this first season resulted in changing 325 miles of the poor roads reported May 1, 1918, to good, at a cost of approximately $200 per mile, and in leaving them in such condition that they can be maintained in the future by ordinary patrol maintenance methods.

Patrol Maintenance.—There was employed on the system a total of 560 patrolmen. Of this number, 125 quit or were discharged during the season. In nearly all cases the vacancies have been filled. Each patrolman was given a rating at the close of the season, based upon the improvement made in his section, rather than upon the actual condition of the section. There were 173 patrolmen in the excellent class; 204 in the good class; 108 in the fair class; and 75 in the poor class. This shows that those in the excellent and good class, or 67 per cent, are really making good and these are the men we wish to employ again next season. Those in the fair class, or 20 per cent, have possibilities of making good if coached properly. Those in the poor class, or 13 per cent, will not be employed another season. On the whole, it is believed that the patrolmen have done wonderfully well. Many of them have had no previous experience in road construction or maintenance, and it has been found that invariably they wanted instructions and advice from the county highway commissioner and the commission to even a greater degree than it was possible to give it to them.

Cost of Maintenance.—The total state trunk highway maintenance funds allotted to the counties for the season ending Dec. 31, 1918, amounted to $1,008,336. In addition to this, many counties made further appropriations for the maintenance of the trunk system. These two funds amounted in all to well over $1,200,000.

The cost of the patrol maintenance of the state trunk system was approximately $600,000 or $120 per mile for the entire season. This amount covers the monthly salaries of the 560 patrolmen, the cost of extra labor on patrol work, and the supplies and repairs used by the patrolmen. The balance of $600,000 covers the cost of the gang maintenance work, previously described, and the unexpected balances that remain to the cridt of a few counties.

Ideas Successfully Put in Operation and Lessons Learned in 1918.—A good earth road may be had for from $100 to $300 per mile by the use of a heavy blade grader and large tractor.

Width and smoothness of surface are of more importance than easy grades.

Where a patrol maintenance system is in operation, no road should have more than a 4 to 6-in. crown for a 24-ft. shoulder to shoulder roadway.

An application of 2 to 3 in. of sandy gravel, not larger than 1 in. in size, on the surface of a clay road will give excellent results. Small stock piles should be deposited along the road for the patrolman's use in strengthening the weak places. Ruts will occur, but persistent light grading or planing will surely result in an excellent and cheap temporary surface.

What is ordinarily termed "sand roads" can be converted into a very satisfactory road to travel by light grading, consisting of moving in the unused top 6 in. of soil to the center for a wearing surface and keeping the surface smooth with a grader or planer. The bad sand requires a mixture of clay if available. If not, a covering of cedar shavings, marsh hay, straw, fine brush or weeds.

The patrol sections should not exceed 8 miles in length for team patrol and the patrolman should live on his section and near the center of it. It would be economy for counties to build a shack for each patrolman near the center of the section. The saving of his time would repay the cost of the shack in two seasons.

The best single tool for the patrolman's use in keeping the road surface smooth is the four-wheeled, two-horse road grader. Next is the road planer.

A wavy, uneven gravel road can be scarified and reshaped with a grader at a cost of from $50 to $75 per mile, and thereby converted into an excellent road to travel. If new material is required it should be of a size that will pass a 1-in. ring.

A 9-ft. gravel or macadam road can be scarified and widened to a 16-ft. width by covering the old surface and 3½ ft. of each shoulder with from 2 to 3 in. of fine gravel. By the persistent use of the light grader or planer, the surface can be compacted without the use of a roller.

A 9-ft. macadam road can be successfully widened to a 16-ft. width by resurfacing with 2 or 3 in. of stone, extending the stone over 3½ ft. of each shoulder and binding the new material with bitumen. If properly constructed, the 3-in. depth of stone on the shoulder will amply care for reasonably heavy traffic.

A badly worn macadam surface can be maintained cheaper by the application of about 2 in. of sand and result in a more satisfactory road to travel than if surface treated. It must be gone over frequently with the road grader or planer.

No road should receive a bituminous surface treatment except where the surface is smooth and clean, and where used, the bitumen should be of a quality and of a sufficient quantity to penetrate the road surface thoroughly. Holes appearing in the surface should be patched immediately by the patrolman. It is a waste of funds to apply surface treatments and not use an absorbent of stone chips, pea gravel, or torpedo sand. The surface treatment of roads taking care of heavy traffic, that have been previously treated, should be continued, provided that they have been properly maintained.

Road Building With Industrial Railway*

By [illegible]

[illegible] operation of [illegible] are as follows:

[illegible] If the hills were not too frequent other power could be provided.

[illegible] material. As such an outfit will handle a large daily volume (at 8 trips per day 300 yd.) and as it requires a considerable crew to [illegible] if there is [illegible] delay in the delivery of road material, or if the loading facili[illegible] of stock piling some material in order to keep going when deliveries are delayed, but this presents the further problem of loading from the stock pile. Our loader could not be utilized and another rig would have to be provided.

Third, a considerable mileage to be constructed from one set-up to avoid the expense of numerous moves. We [illegible] 4 miles each way. If the road is continuous and the move is only from the end of a completed section to a point 4 miles beyond, the moving cost will be a minmum, but if the outfit has to be [illegible] the cost is heavy. Our maximum haul so far has been 4 miles as we have been fortunate in having our work along the railroad with frequent stations. Our outfit consists of a 30-HP. locomotive with underslung tank, 60 1½-yd. side dump steel cars, 1 tracklaying car, 1 hand car and 4 miles of 24-in. gage portable track with curves and switches. The track is 30-ft. rail made up in 15-ft. sections with 7 steel ties to the section.

The outfit cost about $16,000. We depreciate 10 per cent on all the machinery, but only 5 per cent on the track as, at the end of 10 years the salvage value will be at least half the first cost. It is also evident that there will be considerable value in the rest of the outfit at the end of the [illegible]. It is now 5 years old and practically as good as new.

Tracklaying is one of the large items in operating and this will vary considerably according to the character of the soil. In swamp sections where the shoulders have not much stability it is necessary to shim up frequently to keep the track in safe condition, but on a firm soil such as sand or gravel, it does not need much attention after laying. Our cost has varied from $100 to $150 per mile, with an average of about $132.

When the outfit is also used for grading it cuts the tracklaying cost as the track is then in position for the stone work. During a move and while the macadam work is on the short haul, some of the cars and track can be spared for grading without delaying the other work, using a team to haul the train. Especially in soft sections it is very useful and in heavy cuts, working with a small shovel it shows great economy. The fact that the outfit has to be there anyway should be considered as it involves no transportation to and from the job.

Hauling 30 car trains and loading one while the other is making a trip, should admit of an average of 10 trips per day on a haul up to 4 miles (2 miles average haul) and we have made this at times, but various delays, principally in the delivery of stone, have combined to cut the average down to 8 trips. I think the train should average 6 trips on a haul up to 8 miles as the delays in unloading and at the loader would be less and it would only mean an average of 48 miles per day actual running. At this rate, hauling 47 tons per trip would equal 282 tons per day. Speed of train is 8 to 10 miles per hour and time of unloading 10 to 15 minutes. Time of loading is about ½ hour, but of course this does not delay the train. At times when our stone supply was sufficient we have averaged over 400 yd. per day, or at the rate of a mile of road built in 6 days.

The following costs are an average of 3 years, 1914, 1915 and 1916, and cover about 20 miles of 16-ft. macadam construction:

	Per cu. yd.
[illegible]	$0.055
[illegible]	.025
[illegible]	.013
[illegible]	.010
[illegible]	.010
Oil, [illegible] and waste	.002
Repairs	.015
Moving	.025
Total operating	$0.155
Depreciation	.055
Interest	.035
Total hauling	$0.245
Cost per yard mile	$0.1225
Cost per ton mile	$0.098

Delivering the stone on the road as above affords an opportunity of keeping the other construction costs at a minimum. Loading with an elevator is about the cheapest method and spreading the stone with a road machine is cheaper than by hand and planes the road at the same time, avoiding minor inequalities which so often occur. Rollers and sprinklers are kept up to their full capacity.

The other costs of the macadam construction follow:

	Per cu. yd.
Loading	$0.070
Spreading	.160
Sprinkling	.065
Rolling	.210
	$0.505
Hauling as above	.245
Total	$0.750

Contract Prices in Texas State Highway Work

The accompanying tabulation shows the unit contract prices on state highway work at several lettings held last December and January by Texas counties:

	Galveston County, [illegible]	Culberson County, Jan. 15.	Gonzales County, Jan. 15.	Harris County, Dec. 23.	Falls County, Jan. 2.
[illegible]	[illegible]	....	..	..	.....
[illegible]	..	$20.00	$60.00	$200.00	......
[illegible]	[illegible]	.	...	100.0[illegible]	......
[illegible]			. .	0.40[9]	......
[illegible]	..	.24	0.2[illegible]	..	$0.24[illegible]
[illegible] per cu. yd.	..	.60[illegible]	.46	..	.62[illegible]
[illegible] per cu. yd.		[illegible]	.15		.....
[illegible] per cu. yd.	.	.12[16]	.09[17]	.	.10[18]
[illegible]					
Grader work, 6-mule, per mile	..	290.00[19]	.	..	310.00[20]
Concrete pavement, per sq. yd.	..	325.00[22]	. .	.... ..	......
[illegible]	..	1.50[illegible]	[illegible]	.	......
Extra [illegible]	.	.		.	.75[illegible]
Extra [illegible]	.	.		. .	.40[illegible]
	....			.	.80[26]

[illegible] acres. [illegible] acres. 45.5 miles. [illegible] miles. 15.69 miles. [illegible] cu. yd. [illegible]172,610 cu. yd. [9]614 cu. yd. [illegible] cu. yd. [illegible] cu. yd. [15]46,102 cu. yd. [16]4,315 cu. yd. [17]203,455 cu. yd. [18]8,161 cu. yd. [illegible] sq. yd. [illegible]18,485 sq. yd. [illegible] hours. [illegible]200 hours. [illegible]200 hours.

War Increased Cost of California Highway Construction 40 to 60 Per Cent.—The California Highway Commission in its report submitted to the Governor on Feb. 15 estimates that the war caused an increase in cost of highway construction of 40 to 60 per cent over the estimate of 1915, on which the $15,000,000 bond issue was based. Approximately $7,884,000 of the second issue of bonds remain to be sold. Of this amount $3,000,000 must be reserved for construction of lateral roads, the report said, and it is probable the obligations already incurred will require at least $2,750,000 for their fulfillment, so that little more than $2,000,000 remains for new work. The report showed that in the biennial period ending June 30, 1918, a total of 354.53 miles of road had been constructed, making a total of 1617.40 miles of state highway built in California. These figures did not include unaccepted contracts for highways aggregating 349.37 miles in length.

[illegible]

Suggestions for Inspectors on County Road and Bridge Construction

Useful suggestions for the inspection of concrete work in road and bridge construction were given by Mr. C. R. Weymouth, Acting Division Engineer of the Wisconsin Highway Commission, in a paper presented at the recent Road School of the Commission. An abstract of the paper follows:

Simple Test of Clay and Silt in Fine Aggregate.—One of the important essentials in concrete work is the obtaining of proper materials. There are one or two very simple tests that can be made in the field that help establish reasonably well what grades of material are about to be or are being used on any job.

A simple test for the presence of clay and silt in the fine aggregate or sand, consists in filling a fairly large, tall bottle about one-half full of sand, about three-quarters full of water, shaking the contents up well and allowing them to settle for an hour or so.

The results can be easily computed by measuring the number of inches of clean sand left and the amount of clay and silt that rests on the top of the sand.

The Wisconsin concrete specifications are emphatic on the subject of clean sand. The presence of clay and silt in amounts over 5 per cent of the total mass is sufficient for rejection of the sand. In some simple tests of this sort made last summer in division No. 2, carload after carload of sand from high-class commercial washing plants was discovered to have as high as 12 per cent of dirt present. Since this method does not reveal all the silt present, as part of the silt still clings to the sand after the shaking, there was probably more than 12 per cent actually present.

It is a common habit to take up a handful of sand and look it over, call it good and pass along. It is surprising how one can be fooled on the presence of dirt in the sand. Lumps of sand or a crust formed on the sand piles that have just dried out after a rain or a shower are a complete give-away on the presence of clay binder in large amounts—well over 5 per cent.

The clay in the sand will form into balls in the mixer and, if being used in a pavement, will later be found floating on the surface of the wet concrete—to form a hole later on under traffic. With the roller and belt finish, these are not readily discovered. An excess of silt contained in the sand, although it may not affect the strength of the concrete, has a tendency to rise to the surface, resulting in a scaling of the top.

Test for Organic Impurities in Sand.—There is still another factor in sand or fine aggregate to be considered. Some sands contain organic impurities; that is, chemical properties that, when released, affect the chemical action of the cement and hinder the setting up of the concrete. The field test for this is as follows:

Fill a 12-ounce graduated prescription bottle to the 4½-ounce mark with the sand. Add a 3 per cent solution of sodium hydroxide until the volume of the sand and solution after shaking amounts to 7 ounces. Shake it thoroughly and let it stand over night.

If the clear liquid just over the sand and silt is colorless or has a light yellow color, there are no harmful organic impurities present. If there are, there will be a dark colored solution obtained, ranging from dark red to black, and the sand should be rejected unless a mortar strength test can be made and found satisfactory.

Classifying Stone Aggregates.—In using stone screenings for the fine aggregates, there is likely to be present a large amount of dust. An inspector is justified in objecting strenuously to this, as the dust makes proper mixing difficult and, therefore, reduces the strength of the concrete. The coarse aggregates that appear on our concrete jobs are generally easy to classify at once as suitable or unsuitable. The inspector should watch to see that all intermediate sizes are present in the coarse aggregates.

An inspector should be watching for errors in the plan furnished him for the work and should not let errors get by. An inspector who allows work to be done with a feature that looks wrong and is wrong anywhere about it and then excuses himself by saying that the plan called for it in that way, is a poor specimen of an inspector.

Form Work and Thickness of Concrete Paving.—Inspectors, in general, do not pay enough attention to form work for concrete. In the paving work, for example, most of the 6-in. wooden forms used in the state last season, if subjected to close scrutiny, would turn out to be nearer 5½ in. than 6 in. high. This is partly due to the scant measurement in the lumber yards, but is also the result of long use and much scraping of dried concrete from them.

An inspector should see to it that concrete is going in 6 in. deep at the edge of pavement and 8 in. in the middle of whatever depth is called for. One of the hardest things an inspector has had to do in the past was to get this same 6-in. dimension at the edge and 8 in. in the middle of actual concrete in any paving job with an honest or a dishonest contractor. If, through carelessness of an inspector or through some trickery, a dishonest contractor is able to get away with even ½ in. less thickness in the concrete pavement than called for, it means a large profit.

It is interesting to see what even ½ in. in thickness amounts to on a day's run in materials saved. This ½ in. represent 1/14 of the total amount of material that should be placed. In a day's run of 400 sq. yd., which is a small run, there are saved 5 cu. yd. of stone, approximately, and 3 cu. yd. of sand. This stone and sand by the time it is delivered on the road will cost a contractor about $1.50 per cu. yd. at least, and this totals a saving of about $12. If he can get by with 1 in. less, it means $230 extra profit. Inspection will pay the inspector's salary about twice over.

Some form-men make a practice of blocking up forms by placing stones from the coarse aggregate under them. This looks to a casual observer as a reasonable performance, as on the dry hard subgrade the forms appear well blocked up. The inspector is satisfied also that a full thickness is being obtained.

However after the concrete is poured the subgrade becomes thoroughly wet, the strike board comes along and in the process of tamping the concrete with it the forms are forced down, as the stones used to block up the forms settle into the soft wet subgrade readily. This is a camouflaged method of getting a ½ in. less right along and fooling an inspector nicely.

Wooden wedges or strips of board should be used if the forms must be raised as they are larger and do not sink in so readily.

Amount of Water in the Concrete.—Perhaps the one thing that causes as much unpleasantness between an inspector and a contractor as any other thing is the question of the proper amount of wetness in concrete.

Nearly all the old spout mixers had the spouts so arranged that concrete had to be mixed wet to get it to run down the spout. The old idea was to get plenty of water rather than too little. These mixers were built low, with a rather long spout and slight gradient. New spout mixers are getting away from this and the boom mixers, of course, never have bothered in this feature.

The men behind a mixer like to have the concrete wet; it makes so much less work for them. The man operating the mixer is continually urged by these men to give the concrete more water. He has to be a good fellow and let them have it wet accordingly. An inspector is up against this psychological feature and it is one thing that gets on an inspector's nerves—to have to be continually keeping after the mixer operator on this feature. Consequently, it becomes a touchy subject all around. But these sloppy mixes cannot be tolerated, with the concrete splashing over the forms and soaking up the subgrade so that forms are spreading. The concrete is also seriously affected as a wearing surface.

Curing the Concrete.—There is written into the Wisconsin specifications the requirement that after a concrete roadway has been finished it shall be constantly and thoroughly wet night and morning for two weeks. A contractor when he bids for a job knows that this feature is in them; at least, the contractors surely should know it by now.

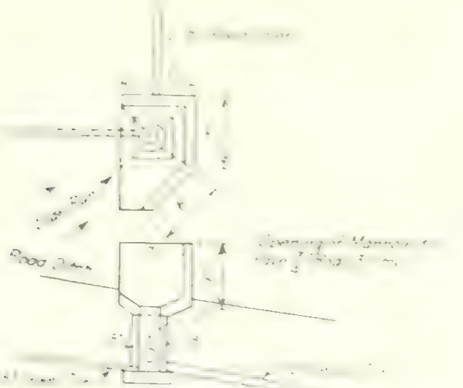
Why is it that it is so hard for an inspector to get this watering done? Even the inspectors have a tendency to question the need of it and take it as a feature that can be neglected. Concrete that has been poured and not properly wet afterward for at least a reasonable time in warm weather will have a permanently bleached-out appearance, with no life or temper in it, and generally the surface shot full of small so-called check cracks. A little shower in the night is taken as an excuse to not wet for the day.

The most serious period of neglect in this curing of the [illegible] the matter so that perhaps the following Sunday the work is done. But every two or three Sundays, however, it is not done and much poorly cured concrete results.

Method of Preventing Erosion of Road Ditches

[illegible]

[illegible] considerable distance—in an extreme case as far as 3,000 ft.—before being able to get rid of the water. In addition in several instances we must also take care of side runs which are steep and will often bring in a large flow of water. To pave these ditches is very expensive and not very satisfactory. Bars, drops, or breakers were tried but there was too much trouble with the water washing around them or under [illegible] seems to wash very easy. It is composed of from 20 to 60 per cent fine clay and the balance fine sand, locally called flour sand. The percentage of clay to sand is very indefinite and the same cut may have all the varying mixtures.



Detail Sketch of Manhole.

To avoid this extreme wash we have laid lines of second grade sewer tile with concrete intakes at intervals up the ditch line. Wherever we have had a side run a regular catch basin has been provided with a concrete man hole and sufficient length of wing walls to prevent any chance of the water cutting around.

Owing to the grade on which these tile are laid—3 to 8 per cent—a tile 12 in. in diameter has been found to be sufficient in most cases. It has been found advisable to cement all joints when laying the tile and to build a concrete headwall at the outlet. After every storm the maintenance man goes over the ditch line and does what repairing he finds necessary and also cleans up the outlet.

By using this method of taking care of the drainage a much narrower ditch can be used with a consequent reduction in the yardage of dirt removed for a given width of road bed and slope to the bank.

A rough sketch of a manhole as used in one case is shown. In this case the manhole was built and tile laid after a very bad washout had occurred, hence the depth of the tile.

Results of Wisconsin Experiment in Covering Sand Roads With Hay-Tar Mat

In October, 1917, the Wisconsin Highway Commission constructed an experimental highway for the purpose of determining the advantages of covering sand roads with hay and hay and tar mats. Twelve sections were built. On six of them tar and marsh hay were used together. On the other sections marsh hay or rye straw covered with a thin layer of sand was put down. The methods of construction were described by Mr. H. J. Kuelling, assistant engineer of the commission, in the Nov. 7, 1917, issue of Engineering and Contracting. The sections were inspected at various times during 1918, the last inspection being made in the fall after the road had been in service for 12 months. The results of this experiment are summarized as follows in the recently issued biennial report of the commission:

The untreated hay was destroyed largely because it rotted and not especially because it wore out.

The untreated hay with sand on it enabled the treated layer to be placed much more uniformly and without the formation of ruts, but the first layer of hay was of no especial lasting benefit to the road.

That the method of applying the tar was not satisfactory. The running of a heavy oiler over the layer of hay formed large ruts in the sand beneath, which could not be removed. Some better method should be devised if this type of road is to be constructed.

Owing to the draft of traffic the hills became bunched somewhat easier than the flats.

Where such a road was to be maintained the second and following years treatments could be much less in volume as to both hay and tar than the original experiment.

The treated sections are several times the life of the untreated sections, just how much cannot be stated.

There was very little difference in the results with hay and straw. This was rather surprising as it was anticipated that the hay would be much more satisfactory than rye straw.

It was determined that the mere adding of sand to an untreated application of hay or straw greatly increased its life, and it was felt that this discovery alone was worth the price of the entire experiment, as many sections in the state have been merely placing hay on the road and by adding the sand they could easily double the life of the hay.

The cost of the experiment was $7 for rye straw purchased at $6 per ton; $156 for marsh hay purchased at $8 per ton delivered on the road. The cost of the teams was $216, the cost of tar $322, making a total of $701 for the construction of 4,977 sq. yd., which were treated with tar to the extent of from one-half to somewhat over a gallon per square yard and of 1,900 sq. yd. which did not receive any tar treatment. The cost of the tar was then 6½ ct. per gallon.

The Commission did not maintain the road in a first-class manner during 1918 because it felt that it was obtaining the information it desired. The engineers of the Commission are satisfied that this type of road can be built and give satisfaction to the traveling public. The cost, of course, will vary very largely as the cost of the tar varies, as it is the largest element entering into the cost. When built on a large scale, many of the items could be very materially reduced as the work could be better organized and it is possible for a large crew to build a long section of road per day.

The Commission does not recommend this type of road excepting where it is impossible to obtain any local clay or gravel. At the present time in some places a mile of 9 ft. road treated in the best manner above described would cost about $1,000 per mile. This might be justified where no other material could be obtained, but the Commission feels that this money could be more economicaly expended if used for the placing of clay or gravel if the same be available within a distance of several miles.

The Commission is satisfied that in extreme conditions this type of road can be economically built and maintained for light traffic, but would not recommend it for a road carrying any large amount of heavy truck or wagon traffic.

The Relation of Street Systems to Highways Outside of Urban District

The need of suitable connections between the primary street systems of a city and the chief highways traversing the immediate surroundings of the city was pointed out by Mr. Nelson P. Lewis, Chief Engineer, Board of Estimate and Apportionment, New York City, in a paper presented last week at the convention of the American Road Builders' Association. An abstract of the paper follows:

The interest of the city, the county and the state is still largely confined to the system of streets or roads under the jurisdiction or control of these several units, and they have not been regarded as one great system of vital interest to all the people.

Rural highways connecting more or less important centers of population are generally much older than any part of city street systems except those in the oldest parts of the towns, while the outer and newer parts have been much more recently planned. It might have been assumed that the traffic between these centers of population would continue to follow these old routes, and yet how often it is found that they are reached only through streets of minor importance, often shabby and unattractive, not infrequently by means of awkward and obscure offsets, so that the dominant feeling is one of relief in leaving them or of extreme unpleasantness in entering them. The same experiences are likely to await the tourist in approaching or leaving the smaller town or satellite city.

On the other hand, when a county or state road system is being improved, even when the roads selected for improvement lead directly to well established city streets of adequate width, and where the further expansion of the city is quite certain to follow along this trunk highway, an increase in the width of such road as it approaches the city, the improvement of its alignment and grades, special attention to its cross-section and drainage, the planting of trees and a little more care given to the road-side would be of incalculable benefit and involve little additional cost, while it might save much expense for future widening and much annoyance through traffic congestion. Of course this requires vision, a quality all too rare, and it may even involve the diversion of traffic through by-passes about already existing centers.

The value of a trunk line highway is generally in proportion to its length, provided it is well improved throughout, and the value to the public of its improvements depends in no small degree upon the promptness with which the entire improvement is carried out, so that it may be made available for modern traffic for its entire distance. There are cases where an important state highway has been improved for long distances on both sides of a town and up to its corporate limits, but the town is not disposed to undertake a similar improvement of the portion of the road within its limits. The state may have the right to, and in equity it should, bear a certain portion of the expense, this portion depending upon the width at which it is to be improved through the town as compared with the width of the part outside of the town, but there may be no way of compelling the town to do its part. The result may be a delay of years in the realization of the benefit which would result from the complete improvement of the road, the annoyance and expense of reducing speed or load to adapt them to the bad condition of the road within the town or a detour around it if one is available. Such a detour, where a road is under construction or repair, is accepted philosophically as it holds out a promise of better conditions in the near future, but when due to the deliberate unwillingness of the town to put its part of the road in as good condition as the adjoining rural sections it gives rise to some unkind thoughts and words as to the indifference and backwardness of the community which is responsible for the conditions.

And yet there is often much to be said in extenuation of the attitude of the town or small city which does not promptly undertake its share of the work. It may be a community where real estate values are low, where there are few if any, industries contributing to traffic which uses the road and few who would use it for pleasure, where there are no natural attractions to induce the tourist to stop, where there is not even an inn which one would be tempted to do other than avoid. The taxpayers of such a town think it unjust, and not unnaturally, that they should be called upon to provide a good road for what to them appears to be alien traffic, leaving nothing in its wake but a cloud of dust or a smell of gasoline. Such conditions present a serious problem in the development of a complete state or national improved road system.

It is probable that many of the state highway laws provide for a determination of the proportions of the expense of improving such a link in its road system which should be borne by the state and the town, such proportions depending upon the additional width or the more costly type of the road through the town, but there may be no means of securing prompt action by the town authorities in providing its share of the funds. Such laws, where they exist, are necessarily uniform and inelastic; but even this is better than would be the practice of enacting special laws to fit each case. This would result in endless log rolling, unfair compromise and grave abuse. It is difficult, if not impossible, to standardize where conditions are quite different.

Prompt improvement of the entire trunk highway is the object to be sought. The state should be able to secure this result, but without injustice to communities where the imposition of the share of the cost determined by statute would involve serious hardship. It would seem as though the power to carry out such improvement at the time other sections of the road are improved should be vested in the state, which would become responsible for payment for the work in the first instance, and that the town should be obliged to contribute such share as may be designated by law, provided the law so specifies, with the right of appeal to some high judicial body which would have the power either to decrease or increase the proportion fixed by statute, the decision in each case to be reached after careful consideration of all the circumstances, including population, the assessed value of real estate in the town, its existing debt and tax budget in relation thereto, the amount of traffic originating in the town, the need of other improvements, the width of its streets in proportion to their traffic and probably other factors which would be essential to a fair determination of the issue.

This suggestion may be somewhat crude, but it is put forward in the belief that the conditions which it is designed to meet are a serious obstacle to the prompt realization of a complete scheme of state and national highway improvement, and also in the belief that the value of such a system is dependent in no small degree upon the promptness with which it can be wholly completed. It will probably be found that the cases where a town has obstinately and persistently refused to do its share of the improvement of a trunk highway passing through it are comparatively rare, and that they are quite generally ready to pay not only for the extra width but also for the improved type of surface deemed suitable.

Where a state contains a large city, the population of which is a very large proportion of that of the state and the assessed value of the real estate in which, and consequently its contribution to the expenses of the state, is more than that of all the rest of the state, as is conspicuously the case in New York and Rhode Island, and where none of the state funds for road improvement are expended within the city limits there is likely to be a certain degree of resentment on the part of the city at what it deems an injustice, especially if the city receives no part of the receipts from automobile licenses or registration fees. While this feeling may be justified it must be remembered that a very large proportion of the vehicles using the state highways come from the cities, while few of those in the rural districts are tempted to go to the crowded city streets for pleasure riding or are compelled to do so for business reasons. This is conspicuously true as to the heavy motor vehicles which result in the greatest wear upon road surfaces, the great majority of which are engaged in delivering goods from the large cities, where they are manufactured, to outlying towns, and which probably will soon be engaged in a vastly increased inter-city and interstate traffic.

There has been too much of a disposition in the past to consider city, county and state highway systems as if they were three separate and distinct things, while we will not satisfactorily solve the problem confronting us until we think in larger terms and realize that they are only parts, under different jurisdictions, of a great national enterprise worthy of the best efforts and enthusiastic support of every one of us.

Pavement Guarantees*

[illegible] Your committee recommends that the maximum period should be fixed at [illegible] years.

The [illegible] of the guarantee system are too well known to require elaborate discussion in this report, but it is a fact that present inspection systems have been de- [illegible] reasonable [illegible] the certain or uncertain amount of additional protection accruing from the guarantee clause inserted in almost all paving contracts. If [illegible] must be made more [illegible] and the lines must be drawn more [illegible] materials and workmanship.

Engineering is not an exact science insofar that in all cases a certain factor of safety must be employed and there [illegible] between good and bad. When the results are guaranteed, even though the guarantee is far from perfect, it is human to require a somewhat lower factor of safety than would otherwise be insisted on. Where the contractor assumes no responsibility for his finished work, the inducement to slight it and thereby save money, is greatly increased and the inspecting force must be still more competent, vigilant and trustworthy than would otherwise be [illegible]

The cost of a guarantee bond to the average contractor does not exceed 1 per cent of the total cost of the contract. On a pavement costing $3.00 per square yard this would amount to 3c per square yard, which would barely cover the increased cost of inspection above described without taking into consideration at all the increased bidding price likely to result from increased severity of inspection.

Assuming that the guarantee is only for the normal life of a pavement without repairs, there exists no legitimate reason for the contractor to increase his construction bid by more than the cost of his bond. As between a reliable and established contractor and one who is lacking in experience, resources and equipment, it is easier and cheaper for the reliable contractor to secure his bond and this can only be regarded as a legitimate advantage to him. As a general rule, he will favor a guarantee bond.

Your committee believes that notwithstanding its admitted defects, the guarantee clause serves an effective purpose and in the light of experience is economically justified.

We do not believe that a uniform length of guarantee for all pavements or for the same pavement under varying traffic conditions is logical or justifiable. Certain pavements are composed of blocks which in themselves have a very long life and but little variation is to be looked for in the blocks themselves. Defects which would develop would be almost wholly defects of workmanship and 2 years should be the maximum period required to make this evident, and therefore, the guarantee should be limited to that time. Other pavements are composed of blocks which vary very greatly in hardness and resistance to wear, and for this type we would advocate a guarantee period for the full life expectancy of the pavement without repair, as it is obviously impossible to test every block used in it. Where a pavement ultimately fails through the abrasion or disintegration of the pavement itself and is liable to prematurely disintegrate through improper materials, or mixing, or proportions, we believe that owing to the great difficulty of absolutely preventing these errors by inspection, the pavement should be guaranteed for its full life expectancy without repairs, and this can be reasonably varied to meet different traffic conditions.

We believe that the guarantee clause should be fairly worded so as not to impose upon the contractor responsibility for conditions arising after the completion of the pavement and over which he had no control, and as covering these points would recommend for consideration the form adopted by the Association for Standardizing Specifications at New Orleans in January, 1912. It should also clearly set forth and be agreed to by the contractor that he accepts the guarantee as being within the reasonable life expectancy of the pavement without repairs.

In northern latitudes if the pavement is completed and accepted between Nov. 1st and May 15th, the guarantee period should be extended so that it will expire on the first of June first following in order to insure weather conditions being such as to permit of thorough examination and the making of all necessary repairs before the final taking over of the pavement by the city. This provision may be omitted when climatic conditions render it obviously unnecessary.

Owing to the admitted defects and short comings of guarantees covered by surety bonds alone and the frequent difficulty experienced by cities in having even those repairs due to poor workmanship and materials made on time, we believe that the bond should be supplemented by a cash retainer, legal interest being allowed to the contractor on the amount retained.

For new construction involving grading, foundation and wearing surface we would recommend that 10 per cent of the aggregate cost of these items be retained.

For resurfacing on an old foundation we would recommend a retainer of 20 per cent.

In the case of a 2-year guarantee the whole of the retained moneys should be payable at its expiration and not before. In the case of a 5-year guarantee, one-fourth of the retained moneys should be payable two years after the completion of the pavement and the balance in three equal annual installments. The date when payments of retained moneys become due shall be governed by the clause previously recommended for pavements completed and accepted between Nov. 1st and May 15th. If the contractor, having received 30 days' notice, fails to make and complete the ordered repairs at the time any annual installment (or the whole amount) of the retained moneys becomes due, he shall forfeit to the city the total amount then due unless he shall have obtained in writing from the engineer an extension of the time, when the same provision shall apply at the expiration of the extension period.

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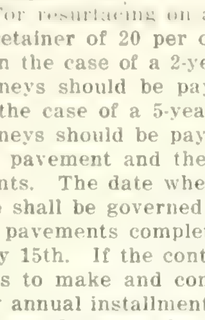
*[illegible] Road Builders' Association. The [illegible] J. H. [illegible] M. [illegible]

Handling Bulk Cement in Concrete Road Work

In constructing 21,400 sq. yds. of concrete pavement in Milwaukee County, Wisconsin, last season, the contractors, Schoonmaker & Winding, Wauwautosa, Wis., employed bulk cement. The cement was shoveled from cars into dump wagons. These wagons were standard equipment except for the sideboards, and had a loose bottom with rear drop gate. One man, assisted by the teamsters, was employed in loading. It was found that two men could unload a box car of usual capacity in 10 hours. The cement was delivered on the job by the wagon and unloaded either by dumping into boxes near the mixer by dropping the gate in the bottom of the wagon, or by means of the hoppered chute shown in the illustration. The chute was hung on the side of the wagon and the cement shoveled into the hopper at the top and released into the lower compartment and in turn into a wheelbarrow placed to receive it, by manipulating, as necessary, the slides. The contractors considered the chute method the best. The losses in handling the bulk cement were practically negligible.



Wyoming to Vote on Bond Issue for Highways.—The Governor of Wyoming has signed a bill authorizing a special state election for a vote on the proposition to create a state debt and to provide for the issuance of state highway bonds. If the issue is carried at the election, about $6,000,000 of Federal and state funds will be available for highway improvement work in Wyoming.

Suggested Methods of Financing Pavement Maintenance

The need for new legislation to permit the adequate financing of pavement maintenance in Illinois cities was pointed out by Mr. F. C. Lohman, City Engineer of Champaign, Ill., in a paper presented at the recent annual meeting of the Illinois Society of Engineers. We quote from the paper as follows:

The subject of financing road and pavement maintenance has not received the consideration from engineers to which it is entitled, compared with the attention given new construction. It is comparatively easy to secure funds for new construction under our present laws in this state, but it is not easy to secure funds for maintenance. At present in city work we are depending on only two sources of income; first, appropriation from general taxes and second (in some few communities, not all), the revenue from a vehicle license ordinance; and it will not be until some other and more adequate methods of financing are obtained that it will be possible to see the results in maintenance that are not only desirable but necessary.

Most of us are familiar with the results obtained under the first method; that is appropriation from general taxes. In fact nothing has been done. All of our cities have miles of pavement in poor condition due to this method of financing maintenance.

It is argued by some that all maintenance cost should be paid by the user of the street. I believe that traffic should bear some portion of the cost but I also believe that an analysis of the causes for maintenance work would substantiate the statement that the general public, the property owner, or both, should bear a large proportion of the cost.

Maintenance work may be divided into three classes:

First: That made necessary by faulty construction, the cost of which might properly be charged to the general public or the abutting property.

Second: That made necessary by the action of the elements which might also be charged to the property or the public.

Third: That made necessary by the action of traffic and which obviously is chargeable to the user of the street.

The proportion that each should bear is hard to determine, and therefore it is difficult to arrive at a just and proper method of securing funds. Assuming that traffic can be made to pay its just share by the operation of a vehicle license ordinance there appears to be three available ways of obtaining the additional funds necessary, each of which require some new legislation in addition to our present laws. First: By increasing the amount allowed to be levied for general municipal funds. Second: By amending the local improvement act so that a fund may be provided when the assessment is spread. Third: By levying a special tax for maintenance work separate from our general taxes and in addition to the amount now allowed by law to be levied.

Whatever the method adopted of increasing funds for maintenance, I believe that it should, first, insure the using of the money for one purpose only; second, that the amount of money available be sufficient to cover the full needs of the community. The method of determining these needs to be based upon scientific principles, i. e., upon the yardage and kind of paved streets; and third, that it should be elastic enough to cover future expansion of cities along this line.

The first method (that of increasing the general taxes) stated above would fail to comply with any of these requirements in that the money could not be set aside by law for special purposes and the same conditions existing at present would still prevail; therefore sufficient funds would not be set apart to serve the needs of maintenance and consequently scientific methods could not be employed to determine the amount and distribution of money required.

The second method (the amending of the local improvement act) would fulfill all conditions. It would be elastic, specific, and scientific principles could be employed but it would have the disadvantages of conflicting with the idea that most people have, that when a pavement is once constructed the public should care for it. It would also increase the cost of the improvement to such an extent as to retard much needed developments.

The third method (a special or additional tax) would fulfill all conditions and have none of the objections of the first two methods and in addition it would be the easiest to obtain from the legislature. From what I can learn this legislature is more apt to provide funds in this manner than any other, because the need is usually apparent and the amount not excessive. Hence, I believe that this method is the most desirable and that the engineers of the state should take some concerted action to secure legislation along this line.

I wish to recommend that this society at this meeting take some definite action towards presenting this matter to the legislature during the present session.

Methods of Snow Removal from Highways

The insistent demands of modern traffic have made necessary the removel of snow from the surface of highways in industrial and commercial areas. Efficient methods of keeping these highways open in winter were outlined by Charles J. Bennett, State Highway Commissioner of Connecticut, in a report submitted Feb. 28 at the annual convention of the American Road Builders' Association.

In order to make a study of snow removal, the general conditions which govern the amount and character of the snow to be removed must be carefully considered. These may be classed as follows:

Geographical Location of the Section.—This determines the amount of annual snowfall, and the approximate greatest fall per storm which must be taken care of; also the usual moisture content, which is a large factor in determining the amount of equipment needed. In defining this general class further, for convenience we may consider three sub-divisions:

(A) Locations where the total depth of any one storm is not over 9 in., and the total snow fall not over 3 ft.

(B) Locations where the total depth of any one storm is not over 18 in., and the total snowfall not over 6 ft.

(C) Any location where conditions are more severe.

Local Conditions.—These are the usual cause of excessive accumulations of snow at any given point. The general direction of the road, combined with the prevailing direction from which the snow drives, causes much difference in the depth of snow to be removed. A side-hill location, or location of a road in a cut, will cause the accumulation of snow in the traveled path. Stone walls, fences and untrimmed brush hedges which may run along the roadway, form the most usual cause of drifts. A study should be made with the purpose of eliminating, as far as possible, any special accumulation from these causes. Hedges may be trimmed, walls removed, and snow fences installed. This work, properly carried out, will eliminate the formation of many drifts. If nothing can be done to prevent the formation of drifts, special efforts should be made to handle this accumulation locally, without leaving it to the equipment which handles the bulk of the work.

The removal of snow in particularly congested districts, such as city streets, is a special problem which requires an entirely different equipment from the general snow removal on highways. Under these conditions special studies should be made of local conditions, as the bulk of the snow has to be picked up and moved away from the streets themselves.

The location on the travel-way of the trolley tracks, from which the traction companies remove the snow by plows, necessitates about double the amount of snow removal from the remaining portion of the road surface. This usually occurs in thickly populated districts, but often occurs on interurban lines between towns. Equipment necessary to handle this class of work will have to be about double that of the ordinary work. Arrangements should be made to have extra equipment at these points to assist the regular snow removal equipment, so that it will travel at approximately the same rate of speed as if the trolley tracks were not there; similar to the local arrangements made where drifts cannot be prevented. If this is done, the problem is simplified and resolves itself into the selection of equipment suitable to handle the greatest average fall in any one storm, for the section in question.

Classification of Roads for Snow Removal Purposes.—After determining the amount and character of snow liable to occur, it is then necessary to classify the roads as to the speed at which the work must be handled; the amount of snow to be left on the road, and the width to which the snow should be removed, so that the prevailing class of traffic may use the highway with safety. For this purpose there are, roughly, three classes into which the roads may be divided:

[illegible] heavy [illegible] vehicle traffic.

[illegible] which carry a small percentage of motor vehicles [illegible] to the predominance of horse-drawn traffic.

A [illegible] which carry a negligible amount of motor traffic [illegible]

Under the first class, the snow must be removed as [illegible] [illegible] conditions in this class of road are almost always [illegible] Under [illegible] of traffic.

In the second class the snow need not, necessarily, be completely removed, and the speed necessary for the first class need not be maintained. About 4-in. depth of snow can be left on the road to take care of the horse-drawn traffic, and the width should be sufficient for the safe passage of vehicles, with the possible exception of deep drifts, where the removal to this width would cause an unnecessary expense.

In the third class: The roads in outlying districts where auto traffic is small, simply enough work may be done to allow the passage of the usual class of traffic, which would [illegible] be broken open.

Selection of Snow Removal Equipment.—In selecting the equipment to be used, it is necessary to bear in mind the general classifications, as well as the classifications according to traffic. In general Class A, which includes storms up to 9 in. in depth, it has been found that the use of a plow attached to the front of a motor truck will operate to advantage, and is almost absolutely necessary where speed is the deciding factor, as on the roads carrying a heavy auto traffic. These trucks may be also used to supplement the equipment used on the secondary roads, should they not be sufficiently clear by the time the main roads are finished. Road machines and plows operated with horses may be successfully used on the secondary roads, supplemented as above, by trucks.

The remaining class of roads carry little motor traffic, and it is usually sufficient to open up the drifts so that sleighs may be safely used. This may be done with teams and a bob sled or drag.

In general, Class B, which includes storms up to 18 in. in depth, the use of motor trucks with plows is usually satisfactory, provided enough equipment is at hand and the work is carried on continuously with speed enough to keep ahead of the storm. High powered tractors may be used with V-shaped plows or rotary plows. On the secondary roads in this general section, snow rollers may be used to good advantage, and the outlying roads may be taken care of, as under the first general head.

Under the more severe conditions where the storms of more than 18 in. are liable to occur, the removal of snow is a difficult problem, and should only be undertaken where it is absolutely necessary. In these locations removal by hand is practically the only successful method, and considerable snow must be moved from the roadway proper, as in the case of the removal of snow from city streets. Snow rollers should be used upon the secondary roads, and in the outlying sections the roads simply broken open.

General Conclusions.—First, prevent the excessive accumulation of snow wherever possible by the use of snow fences and the removal of the natural causes of these accumulations. Second, wherever speed is essential and enough equipment can be provided to keep ahead of the storm, plows attached to the front of motor trucks have proved the most efficient method of removing snow. These must be supplemented by local assistance wherever drifts and excessive accumulations cannot be prevented, and wherever snow must actually be moved away. Third: Wherever speed is not so essential and the depth of snowfall is not too great, road machines and plows drawn by horses or tractors are satisfactory. Fourth: Wherever the fall is great the snow may be rolled in the outlying districts, and must be removed from the roadway in thickly settled sections where hand methods are the only satisfactory solution.

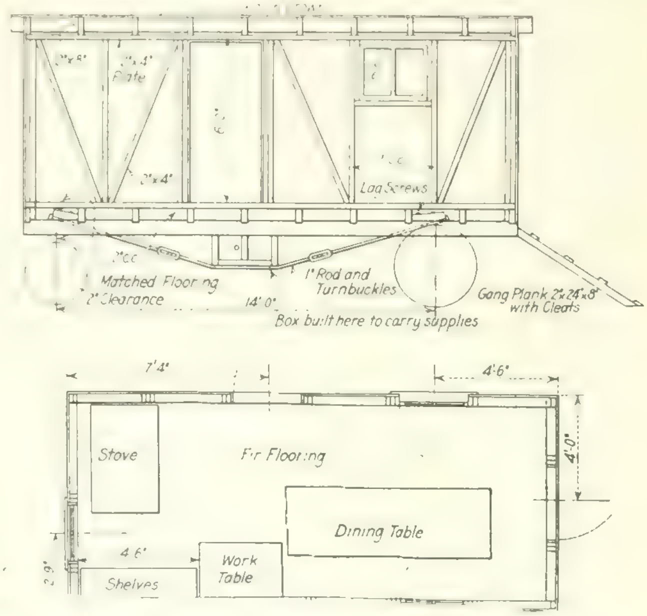
It must always be kept in mind that on main traveled roads snow must be removed to the road surface and for the full width; on secondary roads four inches may safely be left, and single width traffic allowed in deep drifts. On the rural roads it may be satisfactory to simply break out the drifts and make it possible to use sleighs by rolling, if necessary.

Lastly, after traffic has been properly provided for, waterways should be opened up and enough of the snow pushed away from the sides of the road to prevent any hindrance to the proper removal of the next snowfall.

Wagon Camps on County Road Work

Wagon camps are successfully employed by the Road Commissioners of Gogebic County, Michigan, as a part of their road building and maintenance outfits. Each outfit consists of a tractor, two camp wagons and one small truck, the latter being used for hauling fuel and supplies. One camp wagon is fitted out as shown in the drawing. The other wagon serves for a sleeping camp. By suspending single steel bunks on either side of the car and placing one double deck double bunk in one end, sleeping accommodations can be provided for 12 men. The tractor is used for hauling light graders on maintenance work on gravel roads, for distributing gravel for grading and for other purposes. C. F. Winkler is Engineer for the County Road Commission.

Camp Wagon of Gogebic County Road Commissioners.



Elevation of Frame and Ground Plan of Camp Wagon.

Surveyor-Draftsman Examination.—The U. S. Civil Service Commission is holding an open competitive examination for surveyor draftsmen. Entrance salaries range from $1,200 to $1,500 per year. The U. S. Bureau of Public Roads and the Forest Service are making appointments from this examination. Competitors will not be required to report for examination at any place, but will be rated on the following subjects, which will have the relative weights indicated, on a scale of 100: (1) General education, 10; (2) Technical education and experience in plane, topographic, and United States land surveying, 50; (3) Drawing and lettering (from specimens furnished by the Commission), 40.

The Relation of Highways to Railways and Waterways*

By GEO. H. PRIDE.
President Heavy Haulage Co., New York.

The rail congestion in the last two years forced an extraordinary volume of freight on the highways, both long and short hauls. Highway transportation possesses many advantages in that it is more rapid, positively under the control of the shipper, eliminates damage through rehandling, exceedingly flexible, and for these reasons has been eminently satisfactory in almost every instance. So much was this the case during the war that many of those who became familiar with highway transportation were convinced that except for unusually long hauls on high classification material and shorter hauls on very low classification material, freight would be very largely diverted from the railroads and the waterways to the highways. This assumption was incorrect in many instances because it did not take into account the great difference in the cost of the two methods of transportation.

It has been my opinion that under certain conditions, motor trucks can be used to haul certain varieties of freight within a radius of 100 miles, but beyond that radius it would be impossible to haul commodities unless speed of delivery instead of cost was the determining factor. There has been a great deal of open and latent enmity and opposition on the part of rail and water carriers to the development of highway transportation in the past, but this viewpoint has been changing in the last 18 months as the different forms of transportation became more generally understood.

Amazing as it may seem, it was not until competition between the railroads was eliminated that their investigations developed that a very large volume of their short-haul freight was handled at a very heavy financial loss to the railroads, and this condition still persisted even after the rate increases last year. Those interested in the operation of railroads completely changed their attitude when they realized the foregoing truth, together with the fact that highway transportation even under most advantageous and exceptional conditions can only compete successfully on an even basis with railroads, in a 100-mile radius, and in most instances in a radius not exceeding one-third of that.

This change in attitude has produced a desire for co-operation between railroad companies and highway transportation, with the view to diverting to highway transportation that freight, which can be handled within the scope just mentioned. With this new vision of highway transportation the railroad interests began to see possibilities of still further co-operation. There are many regions in this country, particularly in the west, which are supplied with latitudinal railways passing through their states, but ill-supplied with stub-end feeder lines. The Railroad Administration early in its incumbency discontinued the policy of building stub-end lines unless these lines were productive of sufficient local traffic to permit profitable operation. The residents of these localities were very much embarrassed in some instances, as they had raised crops on the promise of the railroads to build stub-end lines. They appealed to the Food Administration and the solution of their difficulty was found in highway transportation, which moved their crops to the nearest available railway station, in some instances, distances over 50 miles.

I doubt whether a policy of building stub-end feeders will ever return to its former practice, which frequently was abused, but rather I think highway transportation will build up traffic in virgin territory, and when the traffic is sufficiently dense to justify profitable operation, then and then only will the stub-end lines be built.

It would, perhaps, be of great interest to realize how utterly dependent on highway transportation is rail and water transportation. Take as an example the Port of New York: With the single exception of that material which is loaded on ships for export or coastwise water traffic, every pound of freight which comes into New York is transported over the highways after it reaches New York. Presume that owing to a blockade of the streets this highway traffic was completely interrupted for a week; in less than this time the terminals in New York would be so congested with cars of undelivered freight that they would practically block the cars loaded with export freight. Presume this happened at all ports along the Atlantic Coast, in approximately less than a week's time all freight would cease to move anywhere east of the Mississippi, because the blockade would reach even those transfer points remote from the coast. The same thing applies to rail transportation.

Again, a huge amount of the freight transported by the rail and water lines is agricultural and farm products. If, owing to a complete blockade of the highways in the agricultural regions, no freight movements were made, comparatively little freight would be moved by the rail and water carriers because it would not be presented to them for transportation. In other words, there is no reason for conflict between highway transportation and rail and water transportation. On the contrary, there should be the strongest co-operation, because while it is possible that highway transportation might survive without either of the other forms of transportation, it is manifestly impossible for either rail or water transportation to exist without highway transportation.

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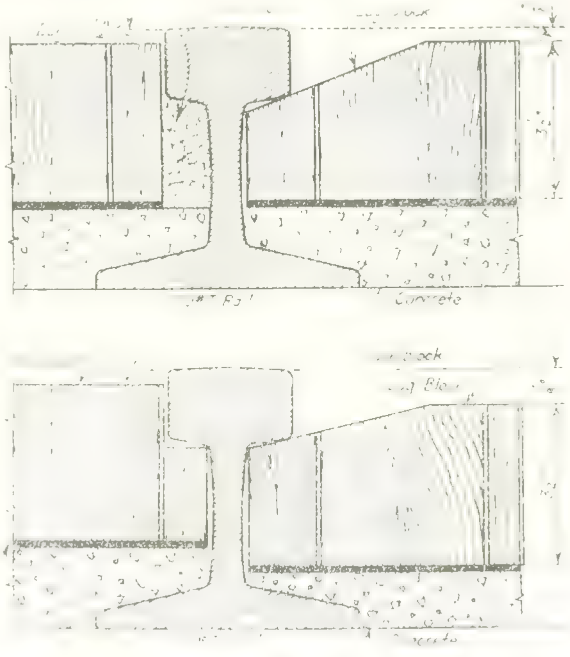
*From a paper presented Feb. [illegible] at the 16th Annual Convention of the American Road Builders' Association.

Street Railway Track Paving with Wood Blocks

In connection with the paving of Dorr St. at Toledo, O., with Kreolite lug wood block, some 10,000 lin. ft. of street car track were put down. About 3,000 lin. ft. of the car tracks were laid with a 7-in. concrete base upon which were placed 6x8x7 untreated oak ties on 2½-ft. centers. One hundred-pound A. R. E. A. rails were used on this work. Upon this concrete base and under the ties was tamped 3 in. of crushed stone. After thoroughly tamping the stone, an additional 6-in. concrete foundation was laid, which was given a smooth finish and a coating of pitch, directly upon which were placed 3½-in. Kreolite lug wood blocks, the wearing surface of the blocks coming ⅞ in. below the inside of the head of the rail and ⅜ in. below the outside of the head of the rail. About ¼ in. of dry sand was then applied as a filler to act as a dam to prevent the pitch from floating the blocks, and the balance of the interstices completely filled with pitch.



Top View, Old Standard Rail Block; Lower, New Rail Block.

An unusual feature of this construction was that instead of crowning the wearing surface between the rails and between the tracks, as usual, the finished roadway was concaved ¾ in. to permit the water to run more readily away from the rails to the center of the tracks or dummy.

The remaining 6,600 ft. of tracks was laid with steel ties as manufactured by the International Steel Tie Co. of Cleveland, O. Six steel ties yere placed to every rail in the tracks and the ties electrically welded to the rail. The bolts were all spotted at the nut to avoid working of the joints. The track was then placed in an 18-in. concrete foundation, finished smooth and the blocks laid as above described.

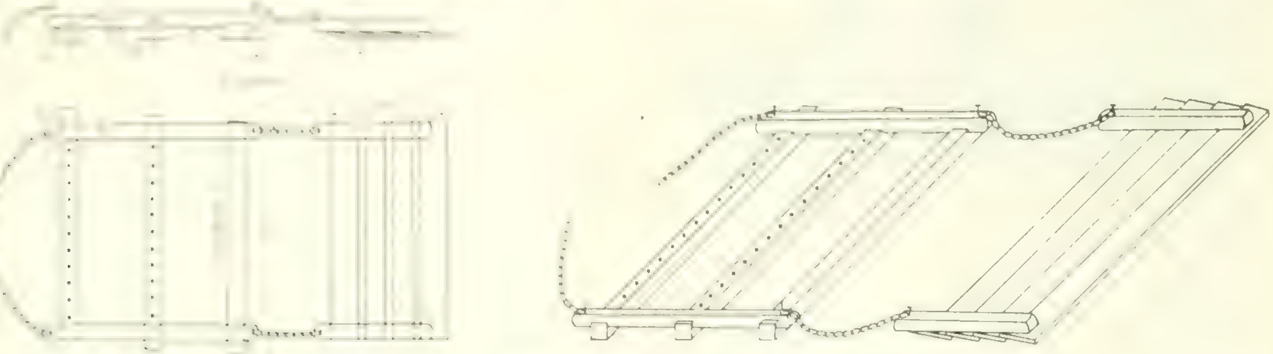
On this section of track 3,400 ft. were laid with the old

[illegible]

[illegible]

Winslow Road Planer

A [illegible] bumps on rural roads is shown in the accompanying sketch. The planer [illegible] at the same time. This device is being used to a large extent by various counties in North Carolina. It is too heavy for a team to pull and consequently is drawn by a tractor. The planer was designed by D. H. Winslow, State Maintenance Engineer, North Carolina Highway Commission.



Winslow Road Planer.

Cost of Road Work in Wisconsin.—The following figures, abstracted from the recently issued 4th Biennial Report of the Wisconsin Highway Commission, show the average unit costs of various kinds of construction in the several counties in 1914, 1915, 1916 and 1917:

	[illegible]	1915	1916	1917
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Guard rail, per lin. ft.	.18	.20	.27	.28

Pennsylvania Will Spend $125,000,000 for Road Work.—Over $15,000,000 has been promised the State Highway Department by Pennsylvania Counties, to be used with state funds in the construction of roads connecting Pennsylvania's Primary Road System, the entire cost of which is to be borne by the commonwealth. The State Highway Department proposed building 550 to 600 miles of road before the winter of 1919 begins. Contracts will be let for many sections within 45 days. In four years it will spend $125,000,000 for better roads.

Highway Contractors' Relief Bill.—A bill is before the senate of Indiana for the relief of contractors engaged in highway construction, who suffered losses from increased prices of labor and material due to the war. The measure provides that in the case of contracts entered into prior to March 13, 1918, the county commissioners may, on petition, hold a duly advertised hearing. Section 4 of the bill describes the relief that may be given, as follows: "Upon a hearing of such petition, such board of commissioners may grant such relief to the petitioner from further performance of the contract as they may deem proper and necessary and may pay for the work and labor done, and materials furnished for that part of the contract which has been completed, at the contract price. Nothing in this act shall be construed to mean that contractors shall be allowed relief from loss sustained on the part of the contract completed. Any person being aggrieved by the decision of such board of commissioners may appeal therefrom to the circuit court of such county in the manner, and within the time now provided by law for appeals from the [illegible] decisions or judgments of board of county commissioners."

No raise in Freight Rates for Road Materials Contemplated. [illegible] Division of Public Works and Construction Development of the U. S. Department of Labor has announced that the re[illegible] increase of 30 per cent in freight rates for sand, slag, gravel and crushed stone were without foundation. The Railroad Administration has assured the Division that no such raise is contemplated at the present time.

$200,000,000 More for Federal Aid Roads.—The Post Office appropriation bill carrying $200,000,000 for Federal aid for highways has been passed by the Senate. Under the bill the maximum payments which the Government can make per mile is increased from the $10,000 in the original Federal aid bill to $20,000.

Personals

B. L. Crozier has been appointed assistant engineer, Paving Commission, of Baltimore, Md.

Capt. Steuart Purcell has been appointed division engineer in charge of highways of the city of Baltimore, Md.

Alfred M. Barrett, Flushing, N. Y., has been appointed superintendent of highways for Queens County, New York.

Capt. Charles A. French, construction division, U. S. A., has resumed his duties as city engineer of Laconia, N. H.

W. A. Fosdick, of Mason, Mich., has been appointed superintendent of county roads of Ingham County, Michigan.

E. E. Sands has resigned as city engineer of Houston, Tex., and will engage in private practice in New York City.

Henry J. Bush, formerly county surveyor of Imperial County, California, has been appointed city engineer of Holtville, Cal.

Lt. Julian Montgomery, U. S. A., has received his discharge from the service and has returned to the Texas Highway Department as division engineer.

George W. Borden has resigned as county engineer of Klicketat County, Washington, to become construction engineer for Trout Lake Improvement District No. 1, organized to construct a concrete road.

LeRoy K. Sherman, consulting civil engineer of Chicago, has been appointed director of the U. S. Bureau of Industrial Housing and Transportation at Washington, D. C. The work involves the completion or salvaging material of 27 war housing projects.

Rollin J. Windrow has resigned as city engineer of Waco, Tex., and will engage in contracting. Mr. Windrow, with J. B. Earle and J. S. Harrison, have formed the Windrow Construction Co., which will specialize on highway and road construction and paving, as well as general construction work. Offices have been opened in the Amicable Bldg., Waco.

Obituaries

F. D. Rich, a contractor of Marquoketa, Ia., died Feb. 15, aged [illegible].

V. D. Minnis, a contractor of Lansing, Mich., died Feb. 21, aged 41.

Charles F. Robbins, a retired contractor of Dayton, O., died Feb. 21, aged [illegible].

Furman Baker, contractor, and former street commissioner of Topeka, Kan., died recently, aged 72.

Robert K. Black, who assisted in the building of the first section of the elevated railroad in New York City and who was for many years roadmaster of Manhattan's elevated system, died Feb. 23 at his home in Scarsdale. He was 82 years old.

Industrial Notes

The Sterling Wheelbarrow Co., of Milwaukee, Wis., is preparing to more completely serve the requirements of its customers by a large addition to its plant. This new addition will contain as much floor space as their present plant now occupies.

The Chain Belt Co., Milwaukee, Wis., held its annual convention of salesmen and sales representatives on Feb. 17, 18 and 19. The convention brought together the company's sales representatives from all parts of the country and from 60 to 90 people were in attendance at all times. The program which was held in the new Milwaukee Athletic Club, consisted of papers by both members of the company and the sales representatives, visits to the various plants of the Chain Belt Co. and demonstrations of concrete mixers.

Waterworks and Hydraulics Monthly Issue

ENGINEERING AND CONTRACTING

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The *articles* in the first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering and contracting field. The *articles* in the first and last issues of each month (1st and 4th Wednesdays) completely cover county engineering and highway engineering and contracting. The *articles* in the third and last issues of each month (3rd and 4th Wednesdays) completely cover steam and electric railway location, design and construction. See the "mast head" on the first page of the Weekly News Section for information about our weekly contract news. See Advertising Page 51 for Subscription Coupon.

Roads and Streets—1st Wednesday
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power

Railways and Excavation—3rd Wednesday
(a) Excavation and Dredging (c) Quarries and Pits
(b) Rivers and Canals (d) Railway Construction Steam and Electric

Buildings and Structures—4th Wednesday
(a) Buildings (c) Harbors Structures
(b) Bridges (d) Miscellaneous Structures

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Why Engineering Societies Should Endorse Meritorious Public Works Projects

Engineering societies have not hitherto considered it to be one of their regular functions to advise the public as to appropriations for public works. Lacking such advice, and owing to the economic ignorance or indifference of legislators and city councils, there has never been an adequate annual expenditure for waterworks, sewers, streets, roads, etc.

Ancient laws have also operated to restrict public works, yet engineering societies have seldom taken any steps to amend such laws. However, not the failure to secure rational laws, but the failure to support rational appropriations for public works, is what we wish to call attention to in this brief editorial.

Times without number civil engineers have made expensive surveys and plans for public works projects, and have recommended construction, only to see their advice ignored by legislative bodies. Yet if engineering societies had endorsed those projects and had campaigned for them, there is little doubt that, in most instances, their efforts would have been fruitful.

In a paper on flood control, presented 18 months ago before the American Society of Civil Engineers, the late H M. Chittenden said:

"The bete noire of the whole problem (of flood control) will be found in making the public fund available with promptness and certainty—unless indeed an entirely new system is devised for the public financing of such projects. When a competent body of experts, designated for the purpose, has reported that a project is feasible and deserving of prompt development, and has set forth in detail the grounds on which its findings are based, there ought to be confidence enough in its recommendations to receive the full support of Congress or legislatures. It is known only too well, however, that hitherto this is far from having been the case, and it is to be feared that, in this broader field of co-operation, traditional methods of delay will cause energetic co-operating interests to throw up their hands in despair. Say what we will, this is one of the drawbacks of our form of government, and the public expert can never be sure of putting through a project until he has satisfied many whose interests therein do not relate to its merits at all. It is in these and similar intangible, yet very real, obstacles, arising wholly from human wrong-headedness, selfishness, and short-sightedness, that the problem which we have been discussing will encounter its greatest difficulties."

Engineering societies, both local and national, should have committees to investigate public works projects. A favorable report by such a committee should be given publicity, and the society should then actively engage in securing the necessary appropriation. To this end the assistance of chambers of commerce and other public-spirited organizations should be enlisted.

Capital flows readily into private enterprises because of the profits that capitalists seek. Capital has to be dragged into public works because little of the profit (at best only 4 to 6 per cent on the investment) goes to the investor. Unless citizens who are directly interested in securing an improvement take action to secure an appropriation, no active effort is made in its behalf, save by public-spirited individuals or organizations. Surely engineering societies should be as public spirited as chambers of commerce and should work in behalf of meritorious public appropriations.

The "Smoke Nuisance" and How It Can Be Eliminated by Civil Engineers

[illegible] an alarming rate.

[illegible] for our comparative freedom from typhoid. Clean air will [illegible] respiratory [illegible]

[illegible] dirty streets [illegible] and disagreeable objects. In the city of Chicago, to take only one of several examples—countless chimneys and hundreds of locomotives are daily spewing the air with soot throughout the winter months. Let a person wash and wipe his nostrils [illegible] an hour [illegible] with black blotches. These blotches are the soot that is sifted out by the fine hairs in the nostrils. But in his lungs are worse blotches from the soot that they have sifted out. People grow old and die fast enough in the purest of air. Such a smoke-laden atmosphere strikes years from the calendar of the average life. Yet the average person does not know it, and goes as complacently to an earlier death as do the cattle to the slaughter pen.

The air of every city can be made pure by being kept pure, and it is the function of engineers to bring this about. Not only is it their function to keep city air pure, but it is peculiarly their duty to arouse the public to authorizing [illegible] knowledge.

As for the dust on city streets the remedy is simple. Street sweeping and flushing under the managerial direction of civil engineers—not of politicians—completely and economically solves the problem. As for the soot in city air, the remedy is equally simple, but it is more expensive. The price of hard coal has risen to an almost prohibitive level. Smoke ordinances are, at least, only palliatives. There can be no complete solution of the smoke problem so long as a multitude of furnaces burn coal. Central heating and power stations must be built if the smoke problem is to be solved.

As Steinmetz recently said, it is an economic crime to burn coal for heating without at the same time extracting energy for power. Obviously this "crime" must continue so long as each building has its own individual furnace. Located in different parts of a large city there should be large [illegible] and heating stations. Powdered coal should be burned in these central stations, not only because it yields almost no soot, but because a greater amount of energy can thus be extracted from the fuel. The steam generated by this coal should be used to drive turbogenerators, thus producing electric power, and the exhaust steam should then be carried through underground pipes to the buildings for heating [illegible]

[illegible] other than those burning powdered coal, should be permitted to operate in a large city. It is not necessary to electrify all the railway lines [illegible] from locomotive smoke. If the public in such cities as Chicago and Pittsburgh knew that locomotives burning powdered coal have already been operated economically and with almost complete freedom from soot, they would not endure another year of smoke clouds from railway yards.

To the civil engineer there is nothing novel in central heating plants. Many cities have them. The Department of the Interior has just issued a 24-page pamphlet, Technical Paper 191, on Central Station Heating. Engineers interested in public welfare, even if not directly interested in heating and steam power problems, will do well to secure this pamphlet. Engineering societies might well assume the duty of educating the public to an appreciation of the fact that "the smoke nuisance" can be abated at a reasonable cost and with ultimate economy to all.

Elsewhere in this issue we quote some interesting data from this paper on Central Station Heating.

The Unfairness of New York City in Its Relations With Water Companies

Although New York State has two public service commissions, neither private water companies nor municipal plants have thus far been brought under their jurisdiction. This has led to a peculiarly anomalous situation in New York City where the city charter gives the municipal water commissioner the power to regulate the rates of water companies.

New York City owns a water plant that has cost $360,000,000 and furnishes 110 gal. per capita per day to 5,000,000 people. Yet there are five water companies operating in one-quarter of the city's area and serving 400,000 people.

In a paper read before the New England Water Works Association by Delos F. Wilcox, an outline was given of the city's policy as to the regulation of the rates charged by the five companies. If any one wishes to see a good example of the unfairness that automatically results when the rates of a public utility company are regulated by city officials, let him read Mr. Wilcox's paper. Mr. Wilcox is a man of high ideals, yet it is evident that he has been unable to escape bias in favor of his employer, the city of New York. For example, he says:

"The city has no desire to destroy the companies' legitimate investments, and for that reason prefers not to enter the territories served by them and parallel their mains for the purpose of competing with them. But the city takes the position that its enormous expenditures for the purpose of introducing an abundant supply of water into the metropolitan area have actually and properly had the effect of depreciating the value of the companies' plants taken as a whole, by rendering portions of them obsolete or nearly so."

Accordingly in valuing the property of a water company the city makes heavy deductions for depreciation due to obsolence, which obsolence is attributable mainly to the fact that the city itself has built a large plant and has surplus water to sell! This reasoning is quite on all fours with that of a big railway company that is prepared to invade the territory of a small railway company, and offers to pay the small company a greatly depreciated price for its property.

In answer to a query by Mr. H. F. Dunham as to "what special features tend to make the life of these water companies so short," Mr. Wilcox replied:

"There are no reservoirs or large conduits which constitute so large a portion of the property in some water plants and which are very long-lived. The mains tend to be smaller than the requirements of the city's future demand; therefore there is a more rapid depreciation on account of obsolescence in the distribution system than would otherwise be the case. The pumping plant and the wells are short-lived properties, anyway, and they are also subject to depreciation by obsolescence because of this great change that is coming over the water-supply situation in New York through the development by the city of the large additional supplies which will inevitably, sooner or later, make these portions of the private companies' plants obsolete, whether or not they are purchased."

Yet in one part of his paper Mr. Wilcox said:

"We took the position, therefore, that the danger of competition should have, if anything, the opposite effect upon the rate of return to be allowed, since the first duty of the regulating authority, from the point of view of the interest of the corporation whose rates are being fixed, is to protect the investment. We believe that the best way to protect the investment, under the circumstances prevailing in these cases, is to keep the rate of return down close to the minimum that will cover the cost of securing money; for in this way charges can be reduced or service improved and the dangers of competition minimized, with a resultant increase in the safety of the investment and the dependability of the revenues from operation."

Note that Mr. Wilcox here admits that the "investment should be protected," but that, as above quoted, he virtually removes the protection when he depreciates the property heavily because of "obsolescence" attributable to the city's own action in building a large water plant.

As a matter of justice there is obviously no defense for such reasoning. As a matter of logic the reasoning itself is sophistical. The sophistry lies in confounding "cost" and "value." A company's "cost" is its investment, and if this is to be protected, as Mr. Wilcox concedes, then no consideration whatever should be given to any depreciation of its plant caused by the existence of the city's plant, such depreciation being purely a matter of competitive value. This general question has been briefly discussed in these columns before, and it is given a long discussion in the recently published Handbook of Mechanical and Electrical Cost Data by Gillette and Dana.

We have touched upon only instances of unfairness toward the private water companies in New York City, and must refer the reader to Mr. Wilcox's original paper for other examples.

Why is it that public employes often act with so much greater harshness in their official treatment of corporations than they act in their private dealings with their fellowmen? Does the word "corporation" serve as a screen behind which they can not see the same sort of fellowmen that they meet in daily life?

Is a New Form of Government Desirable?

When contrast is made between the administration of governmental affairs and the administration of stock companies, a striking difference is seen. But it is not the custom to make such contrasts. We are prone to think that governmental administration must of necessity be cumbersome and wasteful. We look upon our Federal and state legislatures as a necessary part of a democratic government, but are they? The Saturday Evening Post recently said:

"In three weeks the Peace Conference accomplished more in the direction of disposing of the great problems before it than Congress, for example, would have accomplished in six months.

"In view of the number, size and complexity of the problems it may be doubted that Congress would have got that far along in a year.

"That is because affairs at Paris were in the hands of a few men with great power and great responsibility. A dozen men sitting round a table with free, open, brisk interchange of opinion and information could easily do all the work of an ordinary session of Congress in 60 days—and do it better, if they were the right men.

"The traditional democratic method—a big assembly with a public gallery on one side and a press gallery on the other—is a monstrously slow, cumbrous machine for the dispatch of public business. There are times like this present winter, when it seems a coming question whether Congress will not break down and have to be supplanted by a body that can dispose of the work before it in reasonable time. Democracy fairly began in mass meeting like the New England town meeting. Nowadays it has to work through delegates. By and large, its present idea is that a hundred delegates are better than ten. It may have to reverse that idea."

In other words, when the nation adopts the administrative method of [illegible] corporations [illegible] approach to corporation efficiency. In place of several hundred Congressmen there should be one small board of Federal Government directors. Reporting to this board, and selected by it, should be the President of the United States.

In short, the city commission-manager form of Government, which is modeled after the administrative organization of a stock company, is also the form that should be adopted for Federal and state governments.

Cost of Removing Old Wooden Roof of Reservoir and Building New One

In the latter part of 1917 the Water Department of Pasadena, Cal., removed an old wooden roof from its Villa St. reservoir. This roof covered an area of 5.7 acres. It was built in 1899. The cost of salvaging this roof and erecting a new wooden covering are given in the last annual report of the Department.

The roof was 325x495 ft. and contained 251,681 ft. B.M. of lumber. The total cost of removing and salvaging the materials was $781, detailed as follows:

	Total.	Cost per [illegible]	Cost per [illegible]
[illegible]			
Labor	[illegible]		
Auto	[illegible]		
Total	[illegible]	[illegible]	[illegible]
[illegible]			
Labor	[illegible]	[illegible]	[illegible]
[illegible]			
Labor	[illegible]		
Auto	[illegible]		
Material	[illegible]		
Total	[illegible]	[illegible]	[illegible]
[illegible] pipe posts			
Labor	[illegible]	[illegible]	[illegible]
Engineering and [illegible]			
Labor	[illegible]		
Auto	[illegible]		
Total	[illegible]	[illegible]	[illegible]
[illegible]			
Labor	11[illegible]		
Auto	[illegible]		
Total	[illegible]	[illegible]	.1159
Overhead	71	[illegible]	[illegible]
Grand total		[illegible]	[illegible]

The value of the materials recovered was:

[illegible]	[illegible]
[illegible] per M. ft., 119,844 ft..	1,189
[illegible]	$21
[illegible]	[illegible]
Pipe posts sold [illegible]	[illegible]
Appraised value of hardware cloth 72,334 sq. ft. at 3 ct.)....	70
Total	[illegible]

The new roof is the same size as the old one. Its details are as follows: Roofing, 1 in. x 8 in., 1 in. x 10 in., and 1 in. x 12 in. R. W. boards. Joists, [illegible] ft. long spaced 40 ft. c. to c. (west tier 2 in. x 10 in.—20 ft., 4 ft. c. to c.). Girders, 2—2 in. x 12 in. O. P.—18 ft. long spiked together, spaced 15 ft. 9 in. c. to c. Posts, 6 in. x 6 in. R. W. 18 ft. and 20 ft. long with 6 in. x 6 in. x 3 ft. R. W. corbels. Work was begun on Jan. 8, 1918, and was completed March 9, 1918. The detailed costs were as follows:

	Total.	Per [illegible]	[illegible]
[illegible]			
Labor [illegible]	[illegible]41		
Material	[illegible]		
Total	[illegible]	[illegible]	[illegible]
[illegible]			
[illegible]	[illegible]	[illegible]	[illegible]
Auto	12		
[illegible]		[illegible]	.0621
Total		[illegible]	[illegible]
[illegible]		0.123	
[illegible]		190	
[illegible]		[illegible]	[illegible]
[illegible]			
[illegible]			
Total		[illegible]	[illegible]
[illegible] days at $1.952 [illegible]	[illegible]	[illegible]	.0002
[illegible]			[illegible]
[illegible]		[illegible]	[illegible]

Baltimore Adopts Feeding Method for Garbage Disposal

Baltimore, Md., with an area of [illegible] square miles and an estimated population of [illegible], is the largest city in this country that so far has adopted the hog feeding method of disposal of garbage. On Dec. [illegible] last the city awarded a contract for garbage disposal by feeding. The contract covers the period commencing Jan. 1, 1919, and ending Dec. [illegible], and under it the contractor will pay the city an annual sum of approximately [illegible]. Dumping and towing costs to the city will reduce this [illegible], leaving an annual net return to the municipality of [illegible]. The conditions of the new contract are outlined by Mr. Walter E. Lee, [illegible] Engineer of Baltimore, in the official journal of the city, from which the matter following is abstracted.

The City of Baltimore for over [illegible] years made extensive studies and economic investigations of the methods of refuse disposal which were best suited to the local conditions, and Mr. Lee in a report of Jan. 28, 1918, to Mayor James H. Preston, recommended that garbage be disposed of by reduction, [illegible] ashes by filling ravines, low marshes and swampy ground along the water-front for reclamation of land, and rubbish by incineration of the combustible portions, except the recoverable merchandise articles, in three municipal incinerators.

Early Garbage Disposal Methods of Baltimore.—The history of garbage disposal in the city of Baltimore has been successively dumping on ground, reduction and finally feeding. From [illegible] until [illegible] the garbage was barged to a point 6 miles below the city by a contractor and there spread over the ground as a farm fertilizer.

A contract for 10 years was awarded to the Baltimore Sanitary Contracting Co. commencing Oct. 20, 1902, at an annual payment to the contractor of $147,300, for the collection, removal and disposal of garbage and a reduction plant was erected in the heart of the city near the water-front, to which the collection carts of the contractor made a direct haul.

Complaints on the non-collection of refuse became so numerous and objections to the odors from the reduction plant were so strong, that the city terminated the contract on Jan. 1, 1908, and purchased the collection equipment and reduction plant from the contractor at the price of $372,888 and placed directly under the Commissioner of Street Cleaning the collection and removal of garbage from residences.

A second reduction contract was awarded in 1908 to the Southern Products Co. for 10 years, terminating Dec. 31, 1917, at an annual payment to the contractor of approximately $75,000. The reduction machinery was leased from the city at an annual rental of $10,000. At the expiration of this contract it was extended for a period of one year until Dec. 31, 1918, under which extension no rental was paid for the use of the city's machinery, so that the cost of disposal in effect amounted to $85,000.

New Specifications of City for Garbage Disposal.—The specifications recently issued by the city contemplated in the disposal of garbage:

1. That the garbage should be utilized in some way to recover the values contained in it, either by the production of grease and tankage or by increasing the weight of hogs.
2. That the method of disposal should be sanitary in all respects and not liable as a nuisance.
3. That payment per ton be made to the city for all garbage delivered to the contractor.

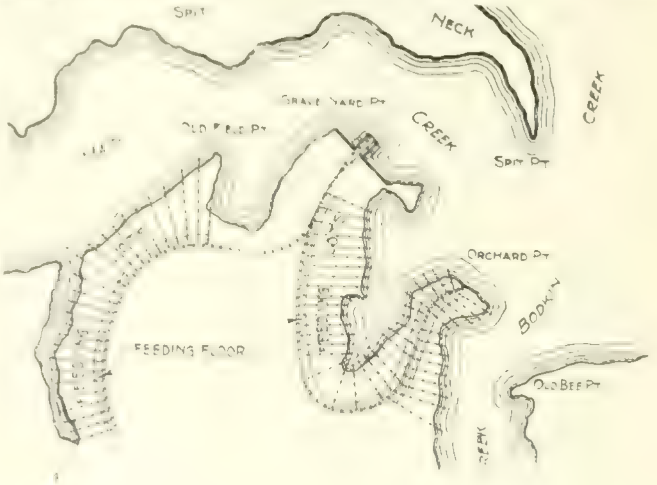
The first specifications for disposal by reduction in furtherance of the recommendation of Jan. 28, were advertised in March and opened on April 17, 1918. It asked for proposals offering a lump sum payment year by year to the city under an 11-year contract and obligated the city to deliver to the contractor all garbage produced from all sources within the city of Baltimore.

The specifications defined garbage as being every accumulation of animal, fruit or vegetable food waste, containing not more than 5 per cent by weight of other refuse, generated by or resulting from the decay, deterioration, storage, preparation or handling of animal or vegetable matter in any place or at any point where food is prepared for human consumption, including all kitchen and dining-room refuse.

The contractor was required to receive the garbage at the water-front dumping stations provided by the city and convey it on his own scows and by his own power to the site of the reduction plant.

The specifications specified that the garbage should be handled and disposed of under a "closed" system of reduction so as to prevent the emission of offensive odors of any kind while being handled, treated or reduced, and that the process, machinery and apparatus be thoroughly sanitary in effect and the plant be so conducted as not to cause conditions which would be detrimental to the public health or comfort, or in any way constitute a public nuisance.

All gases carrying odors which were produced or resulted from the operation of the process, machinery or equipment used, were to be confined and before being liberated to the atmosphere were to be thoroughly deodorized. All water flowing from the plant was to be inoffensive, free from nuisance or any matter dangerous to the public health or to the oyster beds in the Chesapeake Bay or its tributaries.



Feeding Station at Garbage Disposal Site.

Results of Calls for Bids.—Under the first specification a bid offer of 25 ct. per ton was received which would employ the Cobwell process of reduction, but the city was unable to secure the approval of the Capital Issues Committee on the necessary stock issue for the erection of a plant of 350 tons per day capacity, and the bid was subsequently re-[illegible].

A second specification was advertised on Oct. 2 and opened Oct. 16, 1917, under which the city obligated itself to do the same things as in the previous specifications and asked for alternate proposals on disposal by reduction or disposal by feeding. The reduction contract was for 16 years and offered the prospective bidders, without charge, the use of machinery which the city owned in the existing plant for re-erection and operation in a temporary plant until the end of the war, after which a permanent plant was to be erected. The contract for feeding was for 5 years. No bids were received under either reduction or feeding.

A third specification was advertised on Dec. 6 and opened Dec. 18, 1918. Under this specification the city undertook the delivery of garbage from the water-front stations to the contractor's disposal site, as the city realized that the collection and removal of garbage from its water-front dumping stations was simply an extension of the collection and removal from the residences, and a matter in which the contractor has no primary interest. The towing of garbage was a proper function for the city to undertake, the public at large is not always satisfied with the way in which the work is done, but when done by the city the public always has the proper remedy for getting a quick and adequate response to its complaints on the accumulation and non-removal of garbage from the water-front stations.

An Act of the Maryland Legislature prohibits the erection of a garbage reduction plant within a 9-mile radius of Lazaretto Light, a shore light in Baltimore Harbor, and consequently any possible site for such a plant would involve a barging distance of 16 miles from the water-front dumping station in the city and 4 hours of towing either way.

Alternate proposals were again asked on disposal by reduction or by feeding. The term for reduction was 16 years and a flat price per ton was requested with an adjustment, to be stated by the bidder, in cents per ton for every upward or downward fluctuation in the market value of grease from a basic price of 8 ct. per pound, as the city felt that it should share this risk with the contractor so that all elements of gambling in making a bid should be entirely removed.

The term for feeding was 5 years, commencing May 1, 1919, and bids were requested on an annual flat payment to the city for each ton of garbage delivered to the feeding site.

No bids were received under disposal by reduction, and one bid was received under disposal by feeding. The contractor operating the present reduction plant made no formal offer.

Terms of Feeding Contract.—A contract was awarded on Dec. 21, 1918, for disposal by feeding and the price to be paid to the city for each ton of garbage delivered is 3½ times the price per pound of live killing hogs on the Chicago market, as determined by averaging the top prices for each month. The scales for weighing the garbage are located at the feeding site and all garbage is drained before weighing.

Until May 1, 1919, at which time the piggery shall take the full quantity of garbage produced, the city of Baltimore with its own forces will temporarily dispose of its garbage by burying it in shallow trenches 18 in. deep and 5 ft. wide, in which the garbage is placed 12 in. thick and covered with 6 in. of sandy soil. There will be 17,000 lin. ft. required to accommodate this temporary disposal of garbage until the piggery is in operation. The cost of the temporary disposal is 85 ct. a ton against a former cost of $1.06 per ton under reduction, the towing cost being included in both figures.

The city will provide good primary separation and to deliver the garbage in as fresh a condition as possible to the feeding site, with not less than four deliveries per week in summer and three deliveries per week in winter.

The Swine Farm. The 160-acre farm, on which the feeding operations will be conducted, is almost level and has sandy soil, insuring good drainage, with considerable water through an extensive shore line. Scrub pine, chestnut and oak timber affords protection from the summer heat. The farm is owned by the city and was purchased at an average price of $140 per acre. It is situated on a point on the opposite side of the tributary of the Chesapeake Bay on which the existing garbage reduction plant is located and this proximity to a plant which has been operating 11 years without any formal complaint or restraint will insure a like operation of the piggery.

The specifications require that the piggery shall be operated subject to the general and local public laws and under the supervision of such veterinarian and sanitary officers of the county and state as have proper jurisdiction.

The city will also employ a veterinarian who shall have continual supervision and inspection over the work of the piggery.

The garbage which is unfit for feeding or not consumed shall be removed from the feeding platforms, which shall be cleaned at least once a day, and disposed of by the contractor through sale or by plowing under the soil.

Method of Operation of Farm.—It is estimated that 15,000 hogs will be required to accommodate the maximum amount of garbage produced during the summer peak and it will probably represent the largest piggery in the world, and Baltimore will be the largest city of the United States which has adopted this method for its disposal of garbage.

Young shoats, vaccinated with cholera serum, will be purchased in the open market and shipped to the feeding station, where approximately 100 animals will be placed in feeding lots, 70 ft. by 250 ft. in size.

Garbage will be unloaded from the city's scows at the feeding site by the contractor, by the use of a locomotive crane with a grab bucket of one yard capacity.

The garbage will be dropped into steel rocker doubleside dump cars of 10-yd. capacity each on an adjacent track and hauled by an oil-burning locomotive directly down a lane between the feeding lots, as shown on the accompanying map.

The end of the feeding lots adjacent to the railroad will have a monolithic concrete feeding floor from which the animals are excluded by wide gates when the garbage is being dumped from the rockerside dump cars.

When the train has traveled to the full length of its trip, the garbage will be spread on the return trip to the wharf by a spreader from the rear end of the train, after which the gates will be opened and each lot of hogs allowed to enter on the concrete feeding floors to eat the garbage.

Cost of Water Main Construction at Los Angeles

Owing to war conditions the tonnage of cast iron pipe laid in the fiscal year 1917-18 by the Construction Department of the Los Angeles Water Works was the smallest of any year in the history of the Department. Only 1,435 tons were laid as against 4,036 tons for the year preceding and 6,420 tons for the year 1915-16. Of this tonnage, approximately two-thirds was in 4 and 6-in. sizes. The tonnage represents a footage of 75,799 ft., or 14.36 miles, laid at a total expenditure of $103,464. In 1915-16 the average cost of cast iron pipe laid, including resurfacing costs was $50.93; in 1916-17 this had increased to $60.60 per ton and for the year ending July 1, 1918, the charges had mounted to $72.10 per ton. At the opening of the new fiscal year the quoted price of pipe on board cars Los Angeles was $77.60. The following figures from the last annual report of Thos. Brooks, Assistant Superintendent, shows the cost of laying 4-in. and 6-in. cast iron pipe in 6 months' periods from July 1, 1911, to July 1, 1918:

6 months periods from July 1, 1911, to June 30, 1918.	Year.	Av. cost of pipe per ton.	Av. cost of labor per foot.	Average per foot.	Total cost per ton.
		4-INCH.			
1	1911	$32.70	$0.0967	$0.519	$51.90
2	1912	33.88	.0995	.548	51.46
3	1912	35.05	.1189	.607	56.05
4	1913	36.22	.1144	.603	55.62
5	1913	32.42	.107	.553	51.10
6	1914	32.42	.109	.544	50.27
7	1914	[illegible]	.122	.617	59.77
8	1915	30.17	.145	.620	57.18
9	[illegible]	28.85	[illegible]	.626	57.68
10	1916	[illegible]	.115	.669	60.83
11	1916	38.40	.161	.741	68.33
12	1917	43.66	.174	.807	74.42
13	1917	55.60	.175	.93	85.52
14	1918	75.17	.173	1.14	105.51
		6-INCH.			
1	1911	31.60	.133	.745	48.98
2	1912	33.71	.127	.782	49.13
3	1912	33.04	.163	.859	51.56
4	1913	33.93	.1595	.855	51.42
5	1913	31.24	.164	.822	49.34
6	1914	31.24	.170	.836	50.18
7	1914	31.20	.149	.833	50.05
8	1915	28.60	.160	.799	48.91
9	1915	31.09	.171	.878	52.71
10	1916	33.72	.171	.941	56.54
11	1916	34.65	.182	.977	58.71
12	1917	40.11	.212	1.07	64.23
13	1917	41.43	.221	1.11	66.71
14	1918	44.92	.242	1.26	75.23

It will be noted from the table that the increased labor cost, as might be expected, keeps pace with the increasing cost of material. The day wage has been raised from $2.25 to $2.50 to $2.75 and $3, but while wages have been increased, the efficiency shows a decrease of possibly one-third from old standards. Foremen with gangs of less than half the normal number, and many small instead of long straightaway jobs also show their effect on unit costs which in the last year reached the maximum.

Leakage From New Mains.—During the year ending March 1, 1918, the Board of Water Commissioners of Hartford, Conn., made leakage tests of all important sections of new mains laid in the distribution system. In all 23 sections were tested at 100 lb. per square inch pressure, the results being as follows.

Size. In.	Length. Ft.	Results.	Leakage gallons per 24 hours. Per lin. ft. lead joint	Per inch mile pipe
[illegible]	800	Average	[illegible]	[illegible]
8	[illegible]			
10	[illegible]	Maximum	[illegible]	[illegible]
12	4,651			
24	180	Minimum	0	0

The total lengths tested equaled 19,953 ft. and the average cost per foot was $0.0035. The maximum unit cost was $0.0152 for a section 231 ft. in length and the minimum unit cost was $0.0011 for a section 4,200 ft. long.

Special Water Rates for War Gardens.—To increase war gardening the water department of Pasadena, Cal., allowed a special vegetable garden rate of 4 ct. per 100 cu. ft. during the past two seasons. In 1918, 1874 consumers took advantage of this rate

New England Rainfall Records*

[illegible]

[illegible]

[illegible] tion in that section, but any one not familiar with the sub- [illegible] the results obtained at locations not far apart, which often renders any close estimates impossible. As illustrating this fact, the following table has been prepared showing the aver- [illegible] 1913, and also the rainfall for the exceptionally dry years of [illegible] to use. Manchester, N. H., and Providence, R. I., are only [illegible]

[illegible]	[illegible]	Rainfall [illegible]	[illegible]
[illegible]	[illegible]	[illegible]	31.47
[illegible]	[illegible]	[illegible]	39.84
[illegible]	42.01	35.28	[illegible]
[illegible]	41.36	31.73	29.32
[illegible]	[illegible]	35.22	32.65
[illegible]	[illegible]	37.87	31.95
[illegible]	[illegible]	40.06	43.51
[illegible]	47.20	[illegible]	39.54

From this table, it will be seen that even for a long term [illegible] varies greatly, the extreme variation being 8.93 in. or about 23 per cent, while for the dry year of 1880, the extreme variation is 13.99 in., or over 50 per cent. From this it will be seen that anyone attempting to design a water power or a water supply system for a water shed at all remote from a long established rain gage must unavoidably make his estimates upon data which have a large element of uncertainty [illegible]

It has been stated by some writers that a rainfall record of from 35 to 40 years makes that record fairly reliable as a basis of estimates for the expected average yield of a watershed. While this may be true in an ordinary period, an examination of the rainfall records of the last 40 years of the Sudbury River watershed, and others which have commonly been used in this vicinity, shows that a marked change in the amount of rainfall has occurred during the last 15 years of that period and that while the average for the 44 years since the Sudbury River records were begun is 44.66 in., the average for the period 1904 to 1918 (15 years) is only 40.97 in.

The Stony Brook rainfall record of the Cambridge Water Works in Waltham, Mass., shows a similar change. While the average rainfall for the entire period of 29 years the gage has been established—1890 to 1918—is 41.53 in., the average for the period 1904 to 1918 (15 years) is 38.75 in. These last are remarkably low average rates for so long a period and there seems to be but one period of that length of time with so low a rainfall record in this vicinity. This is in the Cambridge record of Prof. A. Winthrop from 1760 to 1775 where the average rainfall is shown as 37.38 in.

Still further, the record of the yield or run off for both these areas shows a corresponding persistent decrease. While the average run off from the Sudbury River area for the 44 years is 20.54 in., the average run off for the last 15 years is 15.85 in. On the Stony Brook area, the average run off for the 29 years is 17.81 in., and the average run off for the last 15 years is only 15.70 in.

If these records are analyzed by percentages, the interesting fact is shown that in the dry periods, the proportion [illegible] to rainfall is less than that in the wet period. [illegible] the wet period in the Sudbury River area 1875 to 1903, the run-off was 49.3 per cent of the rainfall, [illegible] dry period 1904 to 1918 [illegible] per cent, [illegible] the exceptionally dry year [illegible] it was [illegible] per cent, and for the year 1911, it was [illegible] per cent. Similarly on the Stony Brook area, for the wet period, 1890 to 1903, the run off was 42.9 per cent of the rainfall, and for the dry period, 1904 to 1918, it was 40.5 per cent, and for the year 1910, it was only 27.1 per cent of the rainfall. In other words, a diminished rainfall gives not only a diminished run-off, but a diminished proportion of run-off. From these facts, it is evident that it may not be safe to draw conclusions even from a 40-year record, without a careful study of the records of other places and other periods that proper allowance may be made for abnormal results which may have been obtained.

There is another rather curious fact shown in the records for the year 1909 which may be noted. While the rainfall for this year is about 6 in. more than for either the years 1908, or 1910, the run-off for 1909 is about 1.50 in. less than for the year 1908. The Stony Brook record shows the same peculiar result—a lessened run-off in a year of increased rainfall. The explanation of this anomaly may be that the underground storage had become so depleted by the continued drought of a number of years that the increased rainfall for the one year failed to restore the deficiency in this storage and so caused a lessened run-off for that year.

A very important and interesting question may be raised just here. Will the diminished rainfall as noted during the last 15 years be permanent or will the rate "come back" to its old level? While no definite or authoritative answer can be given to this query, two things should be remembered in this connection. No permanent marked changes ever take place in the processes of nature without adequate cause. No such adequate cause is apparent by which the rainfall of this section could be permanently diminished, and again, in the past marked changes have occurred in meteorological conditions, cold winters, hot summers, wet and dry seasons—some continuing for considerable lengths of time, but inevitably the balance has been restored and the general mean of conditions re-established. Even if the period of low rainfall given in Prof. Winthrop's somewhat fragmentary records be taken as reliable as showing the entire rainfall for that period, the records of other observers for following years show the amount of rainfall to be well up to or above the average.

It is rather a curious fact that taking a long term of years, the average rainfall for each month differs but little, the rainfall of the so-called "dry months" being on the average but little less than that of the wet months. The greatly increased evaporation during the hot months, together with the demands of growing vegetation, etc., makes the rainfall seem much less than it really is and results in a greatly decreased run-off during those months. As the evaporation from ponds, brooks, reservoirs, etc., amounts to over 39 in. during an average year, it will be seen that the presence of large water surfaces in a water shed may have an important bearing on the amount of run-off to be expected from it.

The distribution of the rainfall during the year has an important bearing on the amount of the yield or run-off. If the rainfall is largely during the season when the ground is frozen, a much larger run-off may be expected than if it occurred during the hot months, when the ground is dry and the evaporation rapid.

Cost of Meter Repairs at Los Angeles.—During the year July 1, 1917, to June 30, 1918, the meter and service department of Los Angeles repaired 7,248 water meters at an average cost of $1 67 per meter. The average cost of repairing meters of various sizes was as follows:

No. of meters	Sizes In.	Average cost per meter
[illegible]	[illegible]	$1.46
[illegible]	[illegible]	1.54
220	1	[illegible]
[illegible]	[illegible]	2.79
201	[illegible]	[illegible]
[illegible]	[illegible]	2.18
[illegible]	[illegible]	3.88
12	6	[illegible]
1	8	[illegible]

Conditions of Stability and Suggested Design for Wooden Dam Built on Sand

In connection with its stream regulation work the Quebec Streams Commission was authorized to construct a storage dam at the head of the River Jacques Cartier in the province of Quebec. At the only possible site for a dam the river is approximately 120 ft. wide and 4 to 5 ft. deep at average water and probably 7 or 8 ft. deep at high water. The material upon which the dam would rest is a rather firm sand very permeable and soaked with water even at 1 ft. above water level. In view of the bad foundation conditions, the commission called upon Mr. Arthur Surveyor, consulting engineer, Montreal, to investigate and report on the possibility of constructing a wooden dam on sand to store up water to a maximum depth of 23 ft. Mr. Surveyor's conclusions are printed in the recently issued annual report of the commission from which the matter following is abstracted.

The most important conditions which must be fulfilled to assure the stability of a dam built on sand are, to prevent the flow of water through the body of sand on which the dam rests and to protect against erosion the bed of the river immediately below. It is practically impossible to stop the flow of water through the body of sand, but the path of the water underneath the bed may be so lengthened and its passage so obstructed that the velocity of flow can never be sufficiently high to move sand grains. If these conditions are met the foundation will be permanent, but if a stream, of even infinite size, should move with sufficient velocity to carry with it any of the particules of sand the size of the stream would increase and in a short time the whole structure would be undermined. It is evident that the length of the path which it will be necessary to force the water to follow in order to prevent the undermining of the foundations varies according to the depth of storage and according to the nature and to the greater or smaller permeability of the foundations. The length of this path is therefore always a multiple of the height of storage and varies according to a "percolation factor" which changes with the nature of the foundations. Only one engineer, Mr. W. C. Bligh, of Toronto, formerly of the Department of Public Works of India, has given values of this percolation factor.

Nature of foundations.	Percolation factor.
Very fine sand and silt of which 90 per cent passes through a sieve of 100 meshes per linear inch	18
Fine sand, 80 per cent of which passes through a sieve of 75 meshes per linear inch	15
Coarse sand	12
Sand and gravel	[illegible]
Boulders and gravel	[illegible]

It becomes apparent, in examining these factors, that they entail very important lengths of base if the depth of storage of the dam is at all important. For instance in our case, if we adopt a percolation factor of 12, which corresponds to Mr. Bligh's coarse sand, we would have to provide a base of 276 ft. in length. It is possible, however, to reduce this length of base by means of sheet piling placed usually at the upstream end of the dam and by means of a fore-apron, also placed upstream, and resting on the bed of the river.

When sheet piling is placed at the upstream end of the dam it must be absolutely watertight and in calculating the length of percolation it can be taken as equal to a length twice its depth. Besides, it decreases considerably the underpressure on the base. On the contrary the row of sheet piling placed at the down stream toe of the dam, if watertight, increase the underpressure on the base and on this account is generally made loose and placed at some distance downstream from the toe of the dam. Then, the usefulness consists particularly in preventing the displacement of the sand grains by water and in reducing the dangers of undermining. These facts have, recently, been demonstrated in a series of tests made in the United States by J. B. T. Coleman and reported in the transactions of the American Society of Civil Engineers in December, 1915.

The rear-apron has the advantage of reducing the length of the base proper and of decreasing the under-pressure on the base. It is sufficient if this apron be impervious and it can advantageously be formed, by a layer of clay of about [illegible] reinforced concrete slab of about 6 in. thick.

In the United States it is considered that the percolation factor recommended by Mr. Bligh [illegible] length of percolation. In February, 1915, Captain W. A. Mitchell, of the American Engineers Corps, in an article, "Percolation and Upward Pressure of Water," which sums up all the tests and observations up to date, has the following regarding the suggestions made by Mr. Bligh:

"These designs (of Mr. Bligh) are certainly safe enough," and farther in his conclusion, Captain Mitchell added: "Percolation factors for safety against blowout have been assumed by Mr. Bligh, but he does not say on what they are based. Presumably they are based on the fact that smaller factors were present in dams that failed; but this is not entirely conclusive, for in some cases it was evident that other causes contributed to the failure of the dams."

It is also possible to find in a paper by Mr. C. Koenig, entitled, "Dams on Sand Foundations," (Transactions of American Society of Civil Engineers' 1911), and in the discussion by Mr. C. E. P. Smith following this paper, data which differ from those given by Mr. Bligh. The following table indicates the dimensions it would be necessary to adopt for the different parts of our dam according to these three engineers:

Names.	Length in feet of upstream sheet piling.	Rear-apron.	Dam and fore-apron.
W. G. Bligh	41	110	85
C. Koenig...............	28	None	54
C. E. P. Smith	37	None	5

This table sums up very well the differences of opinion on the subject and the difficulty for any designer to arrive at a definite conclusion. There are very few dams constructed on sand and with a storage height of 23 ft. The weirs described by Mr. Bligh and built in India had very seldom more than 12 ft. in height. In the United States are to be found a few examples of hydraulic structures resting on sand: for instance at Prairie du Sac, Wis., the Wisconsin river is completely dammed by the hydro-electric power house and by the dam of the Wisconsin River Power Co., which rests on a stratum of sand of more than 50 ft. in depth. The power house has a length of 369 ft. and the dam more than 1000 ft. The dam is in reinforced concrete and built on piles; the crest of the weir is 16 ft. above the bed of the river but it is raised by means of movable gates of the Tainter type to a maximum storage height of 30 ft. above the bed of the river. This dam is provided upstream with a row of steel sheet piling 50 feet in length; the dam and the fore-apron have a total length of 90 ft.; and at the end of this apron is another row of steel piling of 30 ft. in length, and the bed of the river is further protected against undermining by a stone filling of 20 ft. in width and resting on a brush mattress placed 15 ft. below the bed of the river. This dam was built during the winter and finished in January, 1915. It has stood up against floods which have covered the crest of the weir by 4 or 5 ft. Careful observations made have failed to reveal either important settling of the construction or undermining of the stone filling at the foot of the dam. The length of percolation of water in this dam is 272 ft., which would correspond to a percolation factor of nine.

The dams undertaken by the American Government on the Ohio river in order to create a 9-ft. navigation are particularly interesting. The project embraces the construction of 53 dams and locks at a cost of $17,000,000. All locks and dams built above Louisville, rest on rock or on gravel, but below Louisville, rock has only been found at three dam sites out of thirteen; at other sites the bed changes according to the different stages of the river.

Many of the dams of the Ohio river, notably Nos. 9, 12 and 16, are built on gravel, but rock is generally found about 20 ft. underneath the surface and the structures rest on piles driven to the rock. All these dams are of the movable type and are provided with chanoine wickets of varying heights. The dam No. 12 has a maximum storage of 23 ft. It is formed by a concrete slab 5 ft. thick and 35 ft. in width, with a chanoine wicket of 18 ft. on top. This dam is built on piles driven to the rock. The gravel foundations are protected upstream by a row of sheet piles, 10 in. thick and downstream by a crib 28 ft. wide and 10 ft. high, and [illegible]

[illegible]

[illegible]

[illegible] the highest proposed waters, and as the total discharge of the river should flow over the crest of the dam and through the sluice, the concrete apron provided to absorb the vibrations has been replaced by a reinforced concrete slab loaded with loose stones.

The dam proper is very light and could not by its own weight resist to the water thrust. The weight of the water itself, on account of the slope of the upstream apron, is utilized to resist overturning. The tendency to sliding is counter-balanced by the fact that the dam is bolted to the concrete slab and that this slab is maintained in place on account of its weight, on account of the water on the upstream apron, and on account of its connection to the sheet [illegible]. The [illegible] transmitted by the dam is spread over the bed of the river by the reinforced concrete slab. The upstream sheet piles are of steel rather than of wood because it is absolutely necessary that the cut-off wall so constituted be made water-tight in order to avoid excessive upward pressures against the base of the dam. It is also to secure the watertightness of this base and to avoid the carrying away of sand that the dam has been placed on a reinforced concrete slab instead of on a wooden mattress as is done in certain cases. To build this slab under good conditions it will be necessary to unwater the bed of the river, so that two cofferdams have been provided, one above and the other below the dam and also a temporary wooden flume to allow for the normal discharge from the lake once the floods have passed. These two cofferdams are formed by cribs protected by a row of sheet piling. Once the structure is finished the cribs will be taken away, but the sheet piling will be left in place and would contribute, particularly the downstream row, to prevent the displacement of the [illegible].

The estimated cost of such a dam is as follows:

Items.	Unit prices.	Totals.
[illegible]	[illegible]	$ 27,480
[illegible]	22.00	5,368
[illegible]	[illegible]	11,970
[illegible]	10	9,500
[illegible]	[illegible]	35,100
[illegible]	35.00	7,810
Loose stone filling, 1,000 cu. yd.	2.50	2,500
[illegible]	[illegible]	[illegible]
		$113,123
Cofferdam, temporary diversion, unwatering		15,000
		$128,000
[illegible]		25,000
		$153,000
Telephone line: 30 miles at $200		6,000
		$159,000
[illegible]		10,000
[illegible]		$169,000

Increased Costs of Waterworks Labor & Materials.—In the recently issued report of the Bureau of Water Commissioners of Hartford, Conn., for the year ending March 1, 1918, the increase in prices of materials and labor that have occurred in the last two years in that city is noted as follows:

	Per cent increase
[illegible]	38
Wage of skilled laborer	28
[illegible]	165
[illegible]	100
[illegible]	46

Results of Application of Chloramine Process to Catskill (Esopus) Water of New York City*

By FRANK E. HALE,

[illegible] Department Water Supply, Gas and Electricity, New York City.

The chloramine process consists in combining bleach with [illegible] before applying to the water treated. The [illegible] very simple, the two combining to form ammonium hypochlorite and lime hydrate. The former is unstable and [illegible] intermolecular change, losing water [illegible] chloramine. The reaction is as follows:

$$2\ CaOCl_2 + 2\ NH_4OH = \underset{\text{Chloramine}}{NH_2Cl} + 2H_2O + CaCl_2 + CaO_2H_2$$

In [illegible] theoretical action the ratio by weight of ammonia to chlorine is 1:4. The chemicals must be in very dilute solution to correctly react. We used a 2½ per cent solution of bleach, 0.875 per cent available chlorine on a 35 per cent basis, and 0.22 per cent dilution of ammonia, NH_3. The formation of chloramine is indicated by a much stronger free chlorine test in the water treated, either by orthotolidin or by starch-iodide reaction, than with bleach alone.

Other reactions may be written with different ratios of ammonia to chlorine, but judging from our experience, are incorrect to use. For example, the ratio $NH_3:Cl::1:2$ as follows:

$$CaOCl_2 + 2\ NH_4OH = \underset{\text{Chloramine}}{NH_2Cl} + H_2O + NH_4Cl + CaO_2H_2$$

This reaction has been used at Denver, Colo., and would naturally be the first to be considered, but it actually wastes one-half the ammonia in forming ammonium chloride, and as ammonia costs four times as much as bleach the amount of ammonia becomes a very important item.

Again certain laboratory experiments by Race indicated equal bacterial efficiency for a ratio of $NH_3:Cl::1:8$. As it seemed possible that such a ratio might indicate the formation of a dichloramine, it was tried, but our results indicate that the reaction products are a mixture of chloramine and bleach. The desired reaction, if it formed dichloramine, would be as follows:

$$2\ CaOCl_2 + NH_4OH = \underset{\substack{\text{Dichloramine}\\ \text{(Unknown)}}}{NHCl_2} + H_2O + CaCl_2 + CaO_2H_2$$

With excess ammonia and particularly with strong solutions the reactions take other directions, as mentioned by Hace, with the formation of nitrogen gas and ammonium chloride, as follows:

$$3\ NH_2Cl + 2\ NH_3 = \underset{\text{Nitrogen}}{N_2} + \underset{\text{Ammonium chloride}}{3\ NH_4Cl}$$

or hydrazine hydrochloride thus:

$$NH_2Cl + NH_3 = \underset{\text{hydrazine hydrochloride}}{N_2H_4HCl}$$

During warm weather we made a few analyses of the original solution of ammonia and of bleach as compared with the liquid just after mixing and found a loss of available chlorine of about 20 per cent. This was probably due to reactions such as the above. With excess of chlorine the reactions will not go as above but form nitrogen gas or nitrogen trichloride, a very explosive oil. The latter reaction may be simply written as follows:

$$NH_3 + 3\ Cl_2 = \underset{\text{Nitrogen trichloride}}{NCl_3} + 3\ HCl$$

This probably explains the failure, as given by Race, of chlorine gas to react with ammonia to form chloramine. The reaction would seem very simple as follows:

$$NH_3 + Cl_2 = \underset{\text{Chloramine}}{NH_2Cl} + HCl$$

But the formation of acid apparently must be prevented. We had intended to experiment with chlorination of water with gas and later adding ammonia, but have not as yet tried it out.

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*From a paper presented at the February meeting of the New York section of the American Waterworks Association.

The application of the chloramine process at Phoenicia involved merely separating one tank from the others and connecting it to a new weir box. The two solutions were then brought together at once and passed through the pipe into the stream. The reaction forms lime hydrate which clogs the pipe, causing frequent cleaning. This trouble may be diminished, as suggested by Race, by adding additional flush water with the solutions.

A drum (approximately 700 lb.), of bleach was added to a tank of water at a time and churned by a paddle containing cross cleats until well mixed, as power was not available.

The plant was under close laboratory control. Analyses were made of each tank of bleach solution at beginning, middle and end of run, and similarly of the ammonia solution. The available chlorine was determined by the iodometric method (potassium iodide and acetic acid) and the amount of ammonia by titration with sulphuric acid using azolitmin as indicator. The results were charted each week as shown in Fig. 1.

Very little trouble was experienced in making uniform solutions of ammonia, but owing to improper facilities the bleach values showed considerable variation at times. The average theoretical chlorine applied on a 35 per cent basis for the year 1918 was 0.108 ppm., whereas corrected for analyses of tank solution the average chlorine was 0.102 ppm. During 75 per cent of the time the maximum variation was less than ± 30 per cent of the theory. Likewise during 80 per cent of the time the maximum variation of ammonia from the theory was less than ± 20 per cent.

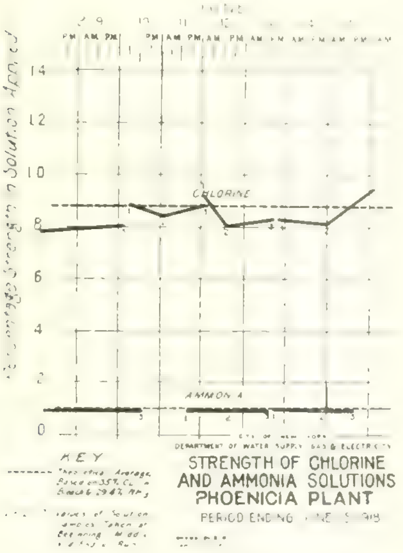


Fig. 1.

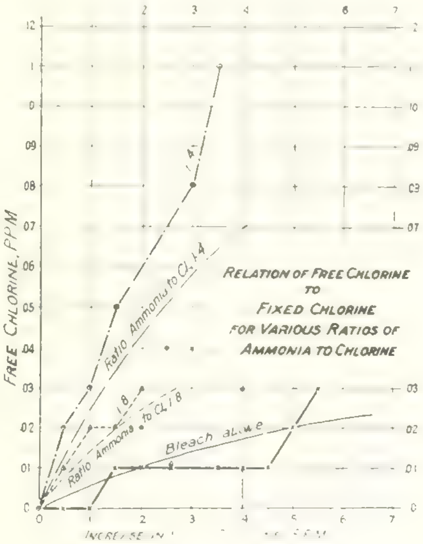


Fig. 2.

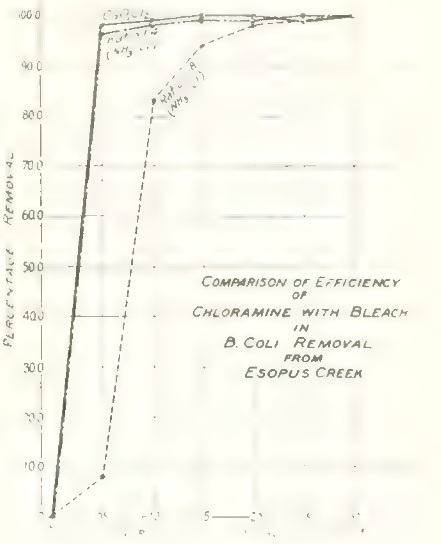


Fig. 3.

Daily analyses were made of the stream before and after chlorination, the latter samples being taken about one-half mile below the plant. This point was decided upon after a series of results at different distances down to two miles. These samples were analyzed physically, bacteriologically and for free and fixed chlorine. In order to make the last determination as accurate as possible the quantity of water evaporated for analysis was increased to 500 cc. early in February and to 1,000 cc. early in June. A chart of all these results indicates a probable error of ± .03 ppm. with the latter quantity evaporated.

The increase in fixed chlorine thus gave a good indication of the amount of chlorine applied to the sample whose bacteriological character was determined. In fact, usually, the free chlorine and bacteriological results varied with the increase in fixed chlorine. Considerable study was made of this point since these analytical results varied with the increase in fixed chlorine. Considerable study was made of this point since these analytical results varied greatly from the theoretical. It is probable that such differences are explained by variation and strength of bleach solution, variation in feed, variation in estimated flow of stream and variation in admixture of chemical solution with the stream. Results have therefore been averaged both by theoretical chlorine applied and by chlorine as determined by analysis: that is, increase in fixed chlorine. The latter seemed to [illegible] the more consistent results.

Comparison of the increase in fixed chlorine with the theoretical chlorine applied for the year 1918 gives an average of .128 ppm. against .108 ppm. Out of 300 analyses 106 agreed with the theory, 94 were above the theory and 100 were below the theory. There was no definite relationship of these fluctuations with the ratios of ammonia to chlorine, but there was a seasonable relationship probably due to variation in stream flow as evidenced by a low or high absolute amount of chlorides present in the water. Thus in the months of April to September there were twice as many analyses below the theory as above and during the months January to March and October to December, the reverse was true. The following table illustrates the above:

TABLE I.—COMPARISON OF ANALYSES [illegible] CHLORINE [illegible]

[illegible]	Samples [illegible]	[illegible]	Samples Below theory.
[illegible]	[illegible]	[illegible]	7[illegible]
[illegible]	[illegible]	[illegible]	23
[illegible]	106	[illegible]	1[illegible]

The above matter has been studied in considerable detail since the results obtained by care in the determination of increase in fixed chlorine by analyses seems to warrant future attention. It is more important than the presence of free chlorine since bacteriological results appear to be obtained even when no free chlorine is left in the water treated.

During the early part of the work bacteriological samples were sent to Brooklyn, but from the first of June these results were obtained at our new Catskill laboratory. Despite delay in transit of samples, comparison of results obtained at the two laboratories has shown that many of the Brooklyn results are sufficiently reliable, particularly with regard to B. coli, to be included in the averages. In many cases the relative number of such samples is too small to greatly affect the results.

The results obtained at the Brooklyn laboratory appear to be reasonably comparable. Noteworthy are the results obtained as to B. coli removal, 93 per cent, with such small dosage of chlorine as 0.05 ppm. when feeding bleach alone and 0.035 ppm. when chloramine, ratio NH :Cl::1:4. The results with 1:8 ratio were decidedly inferior.

Figure 2 shows the results for B. coli removal obtained with various amounts of chlorine applied. With bleach very little or no chlorine is residual in the water, whereas with chloramine, ratio 1:4, the residual free chlorine (determined within a few hours by orthotolidin) increases practically proportionately to the increase in fixed chlorine; that is, chlorine applied. With ratio 1:8 the increase in free chlorine is approximately one-half that obtained with ratio 1:4. These free chlorine results indicate the actual formation of chloramine in those treatments when ammonia was applied and also indicate that with ratio 1:8 the result was a mixture of chloramine and bleach.

The query has frequently been raised as to difference of

[illegible]

Table II is extremely interesting. The amount of residual free chlorine is the same for all temperatures, an average of .033 ppm., in fact 16 results out of 20 tests are .03 ppm. Likewise the percentage bacterial and B. coli removal is similar at all temperatures. The conclusion is inevitable that the actual work performed is the same no matter what the temperature. It is also obvious, however, that B. coli is present in certain quantities in the treated water in the summer periods, but this is due to the fact that pollution is greater in the untreated water in the same period. To remove this B. coli would require the application of a greater dose of chlorine, but only because the raw water was worse and contained more B. coli and not because of any temperature differences. It may also be true that if at any time of year the water should be more highly colored, more turbid, or contain more organic matter, more chlorine might be required, but temperature would not appear to be the reason.

Similar results are obtained if we tabulate the results with bleach alone, but there is no necessity for unduly burdening this paper with tables.

On several occasions while treating with chloramine the water was turbid, as Esopus Creek is apt to be. Usually the turbidity was low, only two or three ppm., and unfortunately such occasions did not occur during use of bleach alone. As chloramine is stated to be less affected by turbidity, the results for chloramine are shown in Table III. It will be noted from this that percentage results were good although several turbidities were considerable.

It may be said in closing that the results for 16 months of it and [illegible] 1 1918 have been included in this [illegible] that the [illegible] obtained within [illegible] appear that the chloramine gave no greater efficiency than bleach alone. That such excellent results were obtained with such small doses of chlorine was a consequence [illegible] the water and can only be explained by the character of the water treated which is practically free from [illegible] extremely low in mineral content and usually colorless and free from turbidity in the absence of storms. During storms the water is very muddy and the flow is beyond the capacity of the plant to treat. Table IV shows average analyses of Esopus Creek for the year 1918, previous to chlorination.

TABLE IV.—AVERAGE ANALYSES OF ESOPUS CREEK FOR THE YEAR 1918 BEFORE CHLORINATION.

Turbidity, ppm.	6
Color, ppm. platinum	6
Odor	[illegible]
Albuminoid ammonia, total, ppm. nitrogen	.029
Albuminoid ammonia, suspended, ppm. nitrogen	.011
Albuminoid ammonia, solution, ppm. nitrogen	.018
Free ammonia, ppm. nitrogen	.001
Nitrite, ppm. nitrogen	.002
Nitrate, ppm. nitrogen	.08
Total solids, ppm.	37
Loss on ignition, ppm.	9
Fixed solids, ppm.	28
Chlorine, ppm.	1.3
Hardness, ppm. calcium carbonate	13
Alkalinity, ppm. calcium carbonate	9
Iron, ppm.	20
Bacteria per cc. 37° C.	111
B. coli, per 0.1 cc., %	17
1.0 cc., %	26
10 cc., %	66
100 cc., %	97

Waterways

We acknowledge receipt of a pamphlet reporting the proceedings of a waterway convention. One speaker, having spent years studying the subject and being copiously fortified with engineers' opinions, statistics of freight movement, and the like, is sure the proposed canal will be of immense benefit to the city and to that entire region. Another speaker, who has likewise given the subject diligent study and is also liberally supplied with citations and statistics, is equally sure the canal will be a sheer waste of money and energy, never doing anybody any real good.

That particular region, as it happens, has been discussing that particular canal for 25 years. So far as we can see it is no nearer a decision about it—to build it or to drop it—than it was a quarter of a century ago. Probably there are 50 canal projects or waterway-improvement projects in about the same state. As a matter of fact, the whole subject of inland waterways is in pretty much that state.

The country makes no decision about it—makes no approach to setting up a national policy based on comprehensive scientific study.

There has been twenty years of discussion all over the country, but the subject is as much up in the air now as it was in the beginning. We are as far as ever from having an authoritative body of experience and opinion by which any given project can be judged intelligently and a fairly satisfactory conclusion reached about it.

We are making no tangible progress in that direction. We can make no real progress until the Federal Government takes up the subject seriously, with an organization and a body of experts capable of leading toward an intelligent national policy. Mostly we just sit round and talk more or less aimlessly.

If the effort now expended on many detached schemes were directed to getting a permanent expert waterways commission better progress might be expected.—Saturday Evening Post.

TABLE III.—TREATMENT OF TURBID WATER WITH CHLORAMINE.

Turbidity		Available chlorine applied. Ratio.	Theory.	Analyt.	Temperature °F.	RAW WATER. Bact. per cc. 37° C.	B. coli per cc. .01	.1	1.	10	TREATED WATER. Bact. per cc. 37° C.	B. coli per cc. 1	[illegible]	10	Per cent removal Bact.	B. coli
[illegible]					[illegible]	[illegible]			+		[illegible]			+	[illegible]	[illegible]
8	Cat.	1:4	0.15	0.25	72	[illegible]			+		[illegible]		[illegible]	+	85	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	71	560	+	+	+		[illegible]			+	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	57	230			[illegible]	+	[illegible]			0	[illegible]	90
[illegible]		[illegible]	[illegible]	[illegible]	41	4					0			0	100	90
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	85						0		0	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					6		0	+	84	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	55	[illegible]					15				[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					20	0	0	[illegible]	[illegible]	99
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	275					[illegible]				[illegible]	90

Central Station Heating: Its Economic Features With Reference to Community Service

An interesting discussion of the possible economies that may be effected through the wider use of central heating is given by Mr. John C. White in Technical Paper 191, issued recently by the U. S. Department of the Interior. Extracts from the paper follow

Engineering attention, technical and commercial, has been occupied with the procuring of a mechanical horsepower or kilowatt hour at the switchboard for the least possible evaporated cost, regardless of the waste of heat not accounted for at that point. The limit of attainment in this direction seems now to have been reached, and yet, with units of the highest type and largest capacity, little more than 15 per cent of the heat of the fuel can be converted into a salable product as power in the form of electric energy. Many installations do not deliver more than 6 per cent of the energy of the fuel as a commercial product. A method that promises at once to increase greatly the community value of such stations in the use of coal is certainly worthy of consideration. This gain can be had by combining with steam power plants a central-station heating system.

Central-station heating affords an opportunity for a great saving in the total fuel consumed by a community, at the same time for furnishing electric energy in greater quantity and at a less cost than otherwise. To make such service a success, however, some important factors must be considered and better methods and designs must be worked out. In the late seventies the first central-station heating plant was put in service at Lockport, N. Y. Since that time many others have been installed with varying degrees of success. Much has been done in the development of methods, the perfection of devices, and the working out of rate schedules and other commercial problems. In certain directions a great deal of room for improvement remains.

Early Rates and Costs.—As regards selling steam on the basis of square foot or radiation, it is interesting to note that although many of the early companies charged a rate of only 20 ct. a square foot for a season of 7 to 8 months, the fuel cost of energizing such radiation for a period of only 6 months (180 24-hour days) with an over-all efficiency of 50 per cent in generation and transmission, steam at atmospheric pressure and a room temperature of 70° F. would be from 10 ct. to 15 ct. with coal at $1 a ton. As few places get their coal at that price, it is easy to see why these heating companies failed. Many electric companies claim a cost of less than 1 ct. per kilowatt hour at the switchboard; the public, however, except a few large consumers, pays three to ten times that amount for what it uses. Steam heating can never carry such an excess as that, but there must be a margin for operation, distribution, overhead costs, and profit. An attempt will be made in the following analysis to determine what difference exists between the cost of central-station service and of private heating to cover those items.

It has been shown above that the average fuel cost of supplying radiation under the conditions named will be about 10 ct. to 15 ct. a square foot for a season of 8 months with coal at $1 a ton. The cost can be readily computed with coal at any other price.

These differences represent charges against dirt, smoke and excess labor. Taking Illinois coal at $1 a ton with a heat value of 12,000 B. t. u. and 49 per cent average efficiency, the cost of energizing a square foot of radiation for 180 24-hour days will be slightly higher than for the central station mentioned above, at which the overall efficiency of generation and distribution was taken at 50 per cent. The fuel costs for the heat are therefore about the same, whether furnished by the private plant or from a central station with the same coal at the same price.

However, there are these differences: The central station can work at a higher sustained efficiency, it can produce electric current as a by-product, with only a small loss of heat generated, and it eliminates all of the objectionable features of a private plant.

Value of Central-Station Service.—The development of equipment and methods of operation in the boiler room of the modern power plant leave little to be accomplished there. soft coal [illegible] ranging from $2.50 to $3.50 a ton on track. It can be burned at an overall efficiency of more than 70 per cent and the product is heat with steam as the medium of transmission. Served in this manner through a distribution system, the heat has a value equivalent to the total cost of all items included in the operation of a private plant plus a considerable allowance for greater convenience and perfect cleanliness, and it should be so estimated in all computations on which costs and rates are based. Whether or not it is exhaust steam in whole or in part has no bearing on the case; any allowance in that direction should affect the price of current and not the cost or the value of the steam. The steam should be considered the prime requisite, with any output of incidentally derived current as the by-product; it will then stand or fall on its own merits, which is the only substantial measurement of its value.

Price of Cleanliness.—As regards the generation and transmission costs and margins, with coal at $3 a ton and an overall efficiency in the plant of 70 per cent, the steam can be delivered at a fuel cost of approximately 30 ct. a square foot of radiation served. This allows 20 per cent for loss in transmission, a figure considerably higher than that found in practice, as evidenced by a report in Bulletin 40 of the Bureau of Mines, where this loss is given at 4 to 12 per cent. The same coal will cost the private user about $4 a ton delivered at his premises, and his fuel cost for the same amount of heat will therefore be not less than 40 ct. But he still has the smoke, dirt, and labor inseparable from the use of soft coal in such equipment as he uses. How much is the elimination of these objectionable items worth? Based on the relative costs of the soft coal and those substitutes—anthracite and coke—which most nearly accomplish the desired end, so far as smoke and dirt are concerned, it is worth from 100 to 150 per cent more than the estimated cost of the heat as computed at 40 ct., making the real value 80 ct. to $1.20 a square foot a season. These values may seem high, but when the economy that is practiced in the use of hard coal at $8 to $9 per ton is considered, they are probably not far from correct. Storm windows are in evidence at the first frost, ventilation is sacrificed, and no space is heated that is not absolutely needed.

Comparison of Costs of Service From Private Plant and Central Station.—The use of the fuels of higher grade eliminates nearly all of the smoke, part of the dirt, and some of the labor; but it is still necessary to provide and maintain a furnace and furnace room, and coal storage, to buy coal, haul out ashes, and do the firing and cleaning. These items may be estimated to cost approximately 50 per cent of the value of the soft coal burned. Assuming that the investment is already made in the private plant, we can make no charge against that except for repairs; these can be neglected, as can also any charge for space occupied by equipment, coal, or ashes. Adding the 50 per cent, or 20 ct. a square foot as determined above, to each of the costs for the various fuels, gives us rates of 60 cents, $1, and $1.40, respectively, for Illinois coal, anthracite, and coke.

The central station can deliver the heat for a fuel cost of 30 ct., thus leaving margins of 30 ct., 70 ct., and $1.10 to cover labor, maintenance, overhead charges, transmissions, and profits. In addition the station has eliminated every objectionable feature of the service and made it a convenience instead of a nuisance. It is a fact worthy of note that central-station heating plants are most numerous where coal is abundant and cheap, as in Pennsylvania, Ohio, Indiana, and Illinois. This confirms the deductions to be made from the preceding statements, namely, that the elimination of the smoke, dirt, and disagreeable labor are of more value in some cases than the fuel cost of the heat. In the localities cited this elimination is essentially what the consumer is paying for. The fuel is so convenient and cheap that the central station can offer no inducements in the way of economy and must make its campaign for consumers on the basis of better service and the elimination of all objectionable features.

Another Method of Computing Costs. If the problem be viewed from another angle, the cost of evaporating a given quantity of water in the large public-service plant as against the small private plant may furnish a better basis for comparison. With Illinois coal at $1 a ton the fuel cost of evaporating 1,000 lbs. of water (generating 1,000 lbs. of steam), should not exceed 7 ct., and in a well-designed and [illegible] The other costs will [illegible] with coal [illegible] The private consumer [illegible] cheaply, [illegible] will have to [illegible] evaporation will [illegible] a little [illegible] are correspondingly great.

In the former estimate of the cost of supplying 1 sq. ft. of radiation [illegible] difference of temperature [illegible] that 1 [illegible] of radiation for the 180-day period. In evaporating 1,000 lbs. of water [illegible] approximately [illegible] per ton. From [illegible] to evaporate the water for each square foot of radiation supplied. To this figure must be added all investment, operation, and other charges on the plant and distribution system. These [illegible] general estimate, but they will probably equal the fuel cost, thus bringing the total up to [illegible] The reader should bear in mind that in the computations made on the quantity of heat emitted the radiation was assumed to be active for the entire period. This will not necessarily hold in practice, and less heat will be required than the amount charged in this discussion. It makes little difference, however, [illegible] will be of about the same amount whether the radiation system is heated privately or from a public-service main.

Rates for Steam.—From schedules of rates in 28 cities [illegible] covering many of the Middle States and ranging in latitude from Michigan and New York to Georgia and Alabama, the highest minimum is $1.50 per 1,000 lbs. of steam at Peoria, Ill., and the lowest for maximum consumption is $0.3105, at St. Joseph, Mo. The lowest minimum consumption rate is 54 ct. at Penn Yan and Geneva, N. Y., and the rate at these points for maximum consumption is 46.35 ct. The average minimum and maximum rates for the 28 cities, on quantities of 4,000 lbs. or less and 300,000 lbs. or more per month, are 76.40 ct. and 45.33 ct., respectively.

Although a study of these rates shows an entire lack of uniformity in the methods of their deduction, the averages given confirm in general the costs established herein for furnishing 1,000 lbs. of steam. In about half of the schedules mentioned there is a demand charge of $3 a month minimum on all buildings having a capacity of 25,000 cu. ft. of space or less, and of 12 ct. per 1,000 cu. ft. on all buildings having more than 25,000 cu. ft.

Economy in Use of Steam.—From the foregoing statement it is evident that economy in the use of steam from a central station is just as important as in the use of the coal burned privately. Will the consumer practice such economy? Under meter rates it may be assumed he will; under flat rates he will not.

The quantity of heat necessary to supply 1 sq. ft. of radiation for a season is probably less than the estimate already given in this paper. Although the heating season is one to two months longer than the period named, there are many days in the early fall and late spring when little or no heat is required. At such times the consumer can reduce his active radiation to any amount desired with less trouble than he can allow his fire to go out and be rekindled. He can also have a little heat in the morning and shut it off for the rest of the day if he desires. A proper demand charge will protect the central station at such times. The station has a decided advantage also, in that the boiler capacity in service can be adjusted to the load and maximum efficiency can thus be maintained.

As with some electric schedules, many rates for steam throw a burden on the small consumer by forcing him to help pay for the large consumer's service. In the case of steam no consumer should be given service for less than a profitable rate. In rates for electric service there is some justification for the apparent discrimination as between the large and the small consumers. The former may make their heaviest demands at times when the load is otherwise small and thus increase the station load factor. In a central-station steam plant the load varies little during the entire day; the demands for steam go up and down with changes of wind and temperature. Such changes are gradual and give ample time for controlling the operation of the plant so that the highest possible economy can be realized. Daily peaks are almost negligible.

Exhaust Steam.—Thus far exhaust steam has not been considered, because there is no difference between it and live steam at the same pressure, and any exhaust steam that may become available for distribution costs just as much and it is worth just as much for heating as though a part of its original energy had not been converted into useful work. In a combined plant the product resulting from such conversion—usually electric current—should be considered [illegible]

Where the heating load is large enough to entirely submerge the power load, there will be no peaks in the boiler room through variations in the latter. The power requirements may vary from zero to maximum and the firemen will not know unless some one tells them or they consult the records. When the engines are exhausting their maximum into the heating system, the reducing valves will automatically cut the supply of live steam to the required amount; when the power load is a minimum they will open and supply live steam to meet the requirements.

Correlation of Loads.—The relations of loads have an important bearing on the subject of central-station heating. When the heating load is made large enough to give constant conditions in the boiler room, the efficiency there is decidedly increased and the power output becomes a matter of secondary importance as far as cost of operation is concerned. Although for commercial reasons, the keeping of the station load factor for power as high as possible is desirable, peaks and variations of any magnitude within the range of the boiler capacity can be handled with a minimum of trouble and expense.

The early efforts—and, perhaps, those of the present—sought to adjust the loads in a combined power and heating plant so that the exhaust steam, considered as a by-product, would do the greater part of the heating, as much live steam as might be necessary being introduced in severe weather. In the average central station such adjustment is practically impossible because of the wide variations in the power of requirements during the day and the comparative uniformity of the heating load. In consequence, some exhaust steam is wasted during part of the day and considerable live steam is required at other times. This procedure leads to the establishment of heating-service rates that are too low, and it is wrong in principle for the reason that it discounts the value of exhaust steam. Fortunately, is some of the successful plants the heating load crept up until a favorable relation existed and, had the rates been equitable, a much better showing could have been made. Where the service is good it is not difficult to book all of the business, or a satisfactory part of it, along the mains. The central station that can supply both heat and current stands a much better chance of displacing the isolated plant than the one that can bid for the current only.

In cities of medium size the same boiler capacity that can supply three or four blocks with current will heat only about one. This fact should make it comparatively easy to take on a suitable heating load within easy distance of the plant where the latter is situated favorably with regard to the district served. By a suitable heating load is meant one in which the power ceases to be a factor so far as the boiler requirements are concerned. As regards steam that has passed from a higher to a lower pressure by doing useful work in an engine, it is in a way analogous to water that is used for irrigation, navigation, or any other purpose after it has driven the wheels of a power plant. The quantity of water remains the same, and if it still has sufficient head or depth it will irrigate as much land or float as large a boat. The steam, after it has passed the engines, will do nearly as much heating as it would before. The curren generated may vary from zero to maximum, with only a trifling increase in the quantity of fuel required.

For this reason the steam should be considered the prime requisite and any current produced should be considered the by-product. The latter will be cheapened somewhat by the process and a correspondingly greater number of people will be benefited by the combination. Also, the fuel will be utilized more efficiently.

Hot Water as Heating Medium.—Steam is most generally used as the medium for conveying the heat to the consumers, although hot water has its advocates, and in some ways it has advantages. Where hot-water radiation has already been installed it is a simple matter to put in a small heater and use the steam for heating the water instead of heating it directly by a coal fire. Nearly any kind of steam or hot-water system that a consumer may have can be satisfactorily operated from the central station mains by using the necessary devices for pressure regulation and control. All installations should have thermostatic regulation if the best economy is to be maintained.

Good Engineering Necessary.—The design, materials of construction, and the methods of operation of district steam-heating plants require careful consideration by competent engineers to insure the success of each installation. Generally, the pipe lines have been iron or steel pipe, several times heavier and stronger than necessary for the pressure carried but failing rapidly by corrosion. It is a false economy to use material not permanently resistant to destructive agents. The pipe is only one item of the underground expense, and means should be devised of making it durable. The best is the cheapest where a long life with low maintenance cost is necessary to success.

The practice has been to lay the mains in the streets or alleys. This is desirable wherever possible. However, in mine and mill work the mains are frequently carried considerable distances overhead. Tunnels are convenient, but their cost is generally prohibitive except in the largest cities. Our city planning should include better provision for underground services than is to be had at present. The streets are practically the same in width and surface arrangement that they were 50 years ago, when gas and water were the only utilities requiring space; at present there are some six or more besides the sewers, and the number will incrase.

Recommendations.—Based on the foregoing discussion it would appear advantageous to—

Select plant locations favorable to the district to be served.

Adopt more permanent construction materials and improved designs.

Submerge the power load entirely at all times during the heating season.

Put all consumers on meter rates with an equitable demand charge.

Run compound engines, or exhaust the turbines tandem to simple engines during the summer months.

Results of a Water Waste Survey at Buffalo, N. Y.

Water consumption at Buffalo, N. Y., was reduced from 350 gal. per capita to 260 gal. per capita as the consequence of a water waste survey. This result was obtained when less than 60 per cent of the city had been covered by the survey. The actual saving was approximately 53,000,000 gal. daily. Of this amount about 10,000,000 gal. was due to underground leakage actually located and stopped, none of which appeared on the surface. The remaining reduction was accomplished by systematic house-to-house inspections, made in connection with pitometer district gagings.

In organizing the work, the city was laid out into 10 sections; each section was divided into 6 to 10 districts. The water was measured by the pitometer in each district, and from the legitimate uses and other conditions in the district, it was determined whether or not a reasonable amount was supplied. The work was started with eight inspectors, and was done under the supervision of one engineer. During the past summer 40 inspectors were on the job, four gangs in the day and two gangs at night, and four engineers in charge of the work.

Underground leakage amounting to 10,000,000 gal. a day was due principally to leaking services. There were found 89 corporation cocks leaking badly, about 90 per cent of them being "unfinished supplies." On one block the leakage amounted to 150,000 gal. a day from nine unfinished supplies. Another cause was blown joints; there were found 21 blown joints and 10 broken mains. The broken mains were the biggest source of loss per leak, states Mr. Egbert D. Case in the March Journal of the American Waterworks Association, to which we are indebted for the above note.

Control of Sewage Filter Fly by Flooding Filter Bed

Drowning has proved an effective measure to kill the myriads of small mothlike flies in sewage sprinkling filters at Plainfield, N. J., states Charles Stewart Beckwith, assistant entomologist, New Jersey State Agricultural Experiment Station, in "New Jersey Municipalities." Slight changes in construction plans and management of plants only are necessary to provide adequate treatment.

In studying the habits of the flies it was determined that the breeding continues throughout the entire season. During the cold months they are present in the larva land pupal stages, emerging with the coming of warm weather. The abundance of the flies during the warm season seems to be correlated with the thickness of the film on the stones of the filter. A thick film means more flies and a thin film, fewer flies. The thick film of late spring gives rise to a tremendous brood. After the film has broken down and sluffed off the number is greatly reduced. Again with the thickening of the film in late summer, the flies become abundant.

The study demonstrated that the control of the pest by the destruction of the adults was impracticable, and that the attack must be made during the immature stages. The study also showed that in the larval and pupal stages the organisms live imbedded in the film and that during both stages they thrust their breathing tubes through this film to obtain atmospheric air. The problem of control was thus resolved into one of finding an agent which would destroy the larvae and pupae and not injure seriously the film on which the efficiency of the filter bed depends. A large number of chemicals were tried. Any of these, when used in sufficient strength to kill the fly, also damaged the film.

In holding over samples of sewage filter film, Dr. T. J. Headlee unthinkingly covered them with water. When he examined the material the following day he found larvae and pupae dead, although other parts of the film seemed normal. This accidental observation, when correlated with the fact that the breathing tubes of maggots and pupae project through the film in such a way as to obtain atmospheric air, led to suspicion that the species could be controlled by drowning. The following table is the compiled result of three sets of experiments:

Length of time flooded, hr.	Condition of larvae and pupae	Condition of film.
16	Alive	Alive*
18	Alive	Alive
22	95% dead	Alive
[illegible]	Dead	Alive
32	Dead	Alive
36	Dead	Slight putrefaction
48	Dead	Putrefaction

*Organisms which largely compose the film alive.

It thus seemed that submergence for 24 hours destroyed 100 per cent of the larvae and pupae. To make the matter more certain one-fourth of the Plainfield sprinkling filter, amounting to a little less than ½ acre, was submerged for a period of 24 hours with ordinary sewage water as it came from the dosing tank. At the end of this period the water was released and many samples were taken. Enormous numbers of larvae and pupae came out with the water, and not one could be found that was alive.

The sprinkling sewage filter beds at Plainfield have concrete containing walls with two outlet chambers leading across it. A permanent fixture permitting quick flooding was arranged by plowing a weir furnished with a gate across the lower end of each outlet. During 1918, no serious brood of flies escaped from the filter bed, although during parts of the summer it was flooded every ten days. The sprinkling sewage filter fly can be controlled practically as well as experimentally by flooding the filter bed with sewage water for a period of 24 hours.

Steam Thawing Outfit for Sewers and Catchbasins.—Steam from a portable boiler was used successfully last winter by the Public Works Department of Scranton, Pa., for thawing sewers and catchbasins. The outfit consists of a small boiler fitted with a firebox grate and mounted on three legs. Soft coal is used as a fuel. The steam is directed into the ice through a ¾-in. rubber garden hose having an iron pipe nipple nozzle drawn to a ¼-in. opening. In one instance a 10-in. sewer, 6 ft. underground, frozen solid for a distance of about 12 ft., was thawed in 8 hours in zero weather.

Recent Installations of Lang Gates

[illegible]

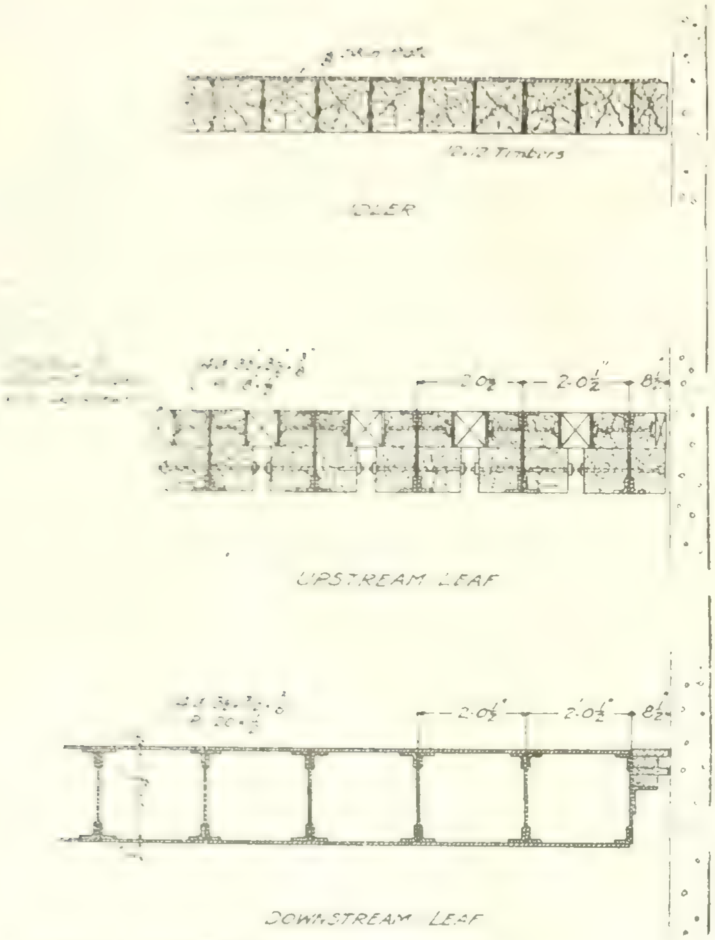


Fig. 1—Cross Sections of Members of Island Lake Log Gate.

[illegible] installations are described by Mr. Donald C. May in a recent issue of The Michigan Technique, to which we are indebted for the matter following.

Lang Gate Regulates Flow for Log Sluicing.—The first installation was in connection with Island Lake storage dam of the Great Northern Power Co., near Duluth, Minn. One of the requirements of this development was a log sluice capable of sluicing within a period of two or three days the entire output of a season's logging operations. After considerable study, a Lang gate was decided upon as capable of satisfactorily discharging the required volume of water necessary for log sluicing operations under the varying conditions of pond water elevation.

The gate has a width of 30 ft., length center to center of pins of 57 ft. and a variation in crest level of 20 ft. No attempt was made to make the gate absolutely water tight at its side edges as a certain amount of leakage was considered advisable to aid in preventing the accumulation of ice during the winter months.

The downstream leaf is of cellular steel construction consisting of 20-in. plate and angle girders spaced 2 ft. ½ in. center to center with ½-in. cover plates top and bottom, making a practically air tight steel enclosed chamber. The upstream leaf consists of 18-in. plate and angle girders spaced [illegible] in. centers with space between girders entirely filled with timbers bolted to the girders making a solid continuous leaf of steel and timber. The idler is a timber leaf made up of 12 in. x 12 in. timbers covered over with ½-in. skin plates and having 8-in. diameter rollers at its upstream end which move upon the flanges of the upstream leaf girders. Each link is made up of two 3x3x⅜ angles riveted together with bent plate link straps. Cross sections showing the construction of the upstream and downstream leaves, and idler are shown in Fig. 1.

Hinges of upstream and downstream leaves are of the ordinary bridge pin type with bronze bushings in pin bearing plates. Curved plates attached to the girders near the hinges of curvature at the center of the pin and passing in close proximity to the curved surfaces of pedestal castings for all positions of the gate effectually prevent leakage of any consequence at the hinges.

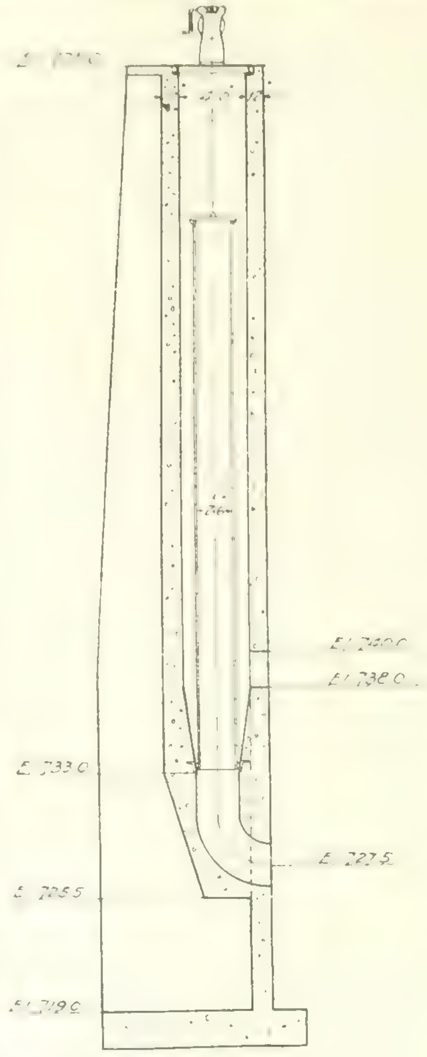


Fig. 2—Section Through Outlet Valve.

A timber side closure, shown in Fig. 1, prevents undue leakage at the sides of the downstream leaf and the upstream leaf and idler timbers have a small clearance at the wall for the same purpose. The hinge connection of the idler to the downstream leaf depends for its water-tightness upon the small clearance allowed between individual hinges. Such leakage as occurs into the chamber of the downstream leaf itself drains out between the girders through drain holes placed between pedestal castings.

The operation of the gate is controlled by the difference in head between the pond and the gate chamber, no auxiliary power being required for its operation under any conditions of pond water elevation. A 24-in. cast iron pipe connects the pond to the inner chamber and a gate valve controls the admission of water. The outlet valve consists of a hollow cylindrical steel tube of 30 in. internal diameter with its bottom edge seating against a casting in the valve well when the gate is in the closed position. The top of the cylinder in the closed position is at the same elevation as the crest of the gate in its up position so that in case of the pond rising above this elevation the water from the inner chamber would discharge over the top of the cylindrical tube and down through its interior, thus automatically helping to relieve additional stress in the gate due to unusual floods. When the outlet gate is open, the cylindrical tube is raised from its seat against the conical casting and the water is discharged into the annular space between the conduit walls and the bottom of the tube. Fig 2 shows a section through the outlet valve.

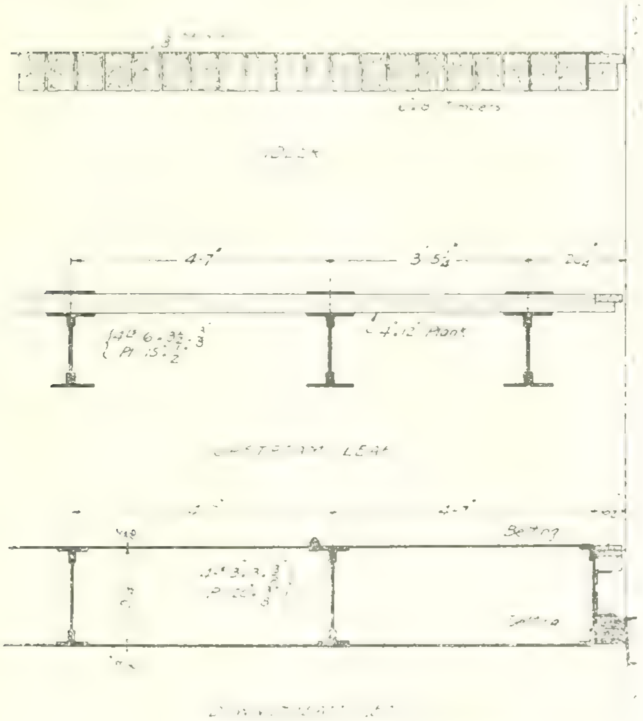


Fig. 3—Sections of Geddes Waste Gates

When the gate is in its up position the links connecting the upstream leaf to the downstream leaf are practically in straight tension and prevent the gate from rising to a higher elevation regardless of pond water elevation. In the down position the upstream leaf rests upon timber pillow blocks and the downstream leaf rests upon the recumbent upstream leaf, buffer blocks attached to the downstream leaf separating the two leaves.

Since its installation in 1914, this gate has given satisfactory service and shows little apparent signs of depreciation. The gate responds readily to the operation of the valves and a very delicate degree of adjustment is obtainable.

Lang Gate Used as Waste Gate.—More recently upon the Huron River, Michigan, at the newly completed Geddes Plant of the Detroit Edison Co., two Lang gates have been installed in lieu of the more usual tainter gates or other waste gates. These gates have a combined capacity at high water of about 9,000 cu. ft. per second, and each is 24 ft. wide, 30 ft. long center to center of pins and has an 11-ft. variation in crest level.

Their construction is similar in a general way to that of the Island Lake gate described above, although sizes of members and spacing of girders is necessarily different. Fig. 2 shows a section through the upstream and downstream leaves and the idler. The upstream leaf has a timber decking rather than having the space between girders filled with timbers as at Island Lake, and the closure at sidewalks is considerably different.

The idler has no rollers at its upstream end but a 6x6x¾ cap angle which slides upon track plates on the timber decking of the upstream leaf.

The downstream leaf in its normal up position was made absolutely watertight at the side wall by the use of belting engaging the back of a channel set into the wall with its downstream edge projecting out about ½ in. from the wall face. The belting is pressed tight against the channel back at the gate [illegible] the up position [illegible] stream hinge was prevented by calking with lead wool, and filling with babbitt to close up the small openings near the shaft and end girder connections. Leakage into the hollow chamber of the downstream leaf itself drains out into the tail race through drain holes between hinge pedestals.

Leakage along the sides of the upstream leaf and idler, from the pond into the gate chamber is sufficient normally to make the need of an inlet valve unnecessary, although one has been provided for emergency purposes. A 24-in. motor operated gate valve controlled from the power house serves as an outlet for the water in the gate chamber.

An arm keyed to an extension of the downstream leaf shaft actuates a rod carrying a pointer in front of a scale which indicates the elevation of the gate crest for any position of the gate.

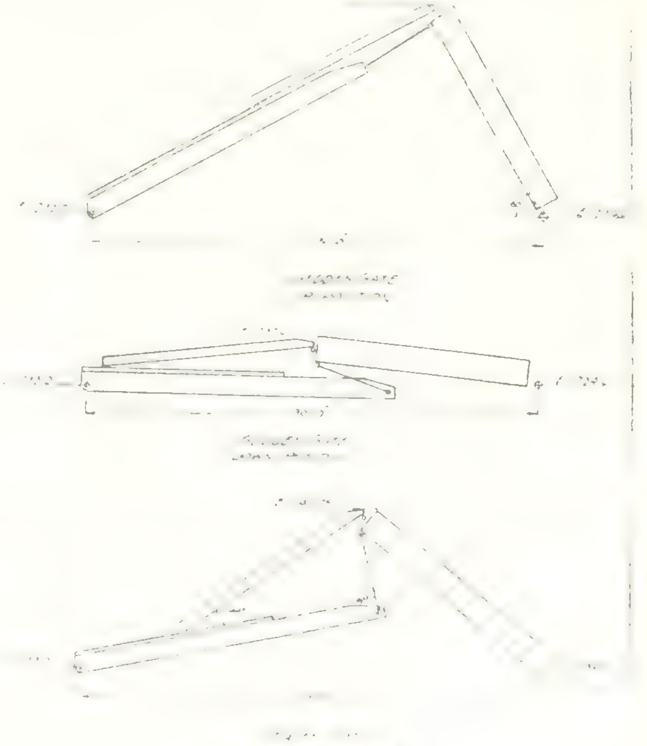
Provision has been made to use compressed air as an aid in lifting the gate in the down position, although this will not be necessary unless unforeseen conditions should occur. Steam pipes have also been placed in the sidewalls along the edges of the downstream leaf in order that if the gate should become frozen in place it could be thawed out by the use of the steam.

The gate normally will not be affected by minor fluctuations in the pond, and will stand in its up position until the pond has fallen 3 or 4 ft. below the crest elevation.

This gate has been successfully operated through a period of about six months and can be said to be absolutely watertight.

Features of Lang Gates.—In the position of the gate (Fig. 4) it will be apparent that the downstream leaf and links will be subjected to the greatest stress, neglecting ice conditions, as the full head of water in the pond will be effective in holding up the gate, by its pressure against the downstream leaf.

The links and upstream leaf will be practically in straight tension while the idler will be subjected to little if any stress. (The density of the upstream leaf with its timber decking—and of the idler is approximately equal to 1). When in the down position (Fig. 5) with water passing over it the gate is raised by admitting water to the inner chamber, thus making the pressure head inside the chamber equal to that of the pond. The buoyancy of the downstream leaf is effective in raising the gate and the construction of the link is such that the downstream leaf may rise by itself 4 or 5 ft. before pulling upon the link to raise the upstream leaf with it. There will be a considerable fall in the water surface through the wasteway when the gate is down and discharging water so that the admission of water from the



Figs. 4, 5 [illegible]

[illegible] too great.

Duty of Water for Deciduous Orchards

[illegible] irrigation project in Victor Valley, California, the Mojave River Commission, consisting of W. F. McClure, state engineer of California; J. A. [illegible] County, California, and C. E. Tait, senior irrigation engineer, United States [illegible] a considerable amount of [illegible] water required for irrigating deciduous fruits. The following is extracted from the report of the commission:

In order to arrive at a proper duty of water for deciduous fruits, data were obtained on the use of water on all orchards in Victor Valley, where the amount applied was measured or where records of value were kept. Data were also secured on orchards in other sections of southern California where somewhat similar conditions obtain.

Information was obtained regarding 53 orchards of various ages, representing a combined area of 1,278 acres. The average amount of water applied to these orchards was .98 acre foot per acre. The results of the inquiry segregating the trees under 5 years of age, and over 5 years of age are summarized in Tables I and II:

TABLE I.—SUMMARY FOR ORCHARDS UNDER 5 YEARS OF AGE.

[illegible]	Number of orchards	Total acres	Total acre-feet	Acre-feet per acre
[illegible]	1	[illegible]	[illegible]	1.08
[illegible]	1	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	.31
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	1	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	..
[illegible]	[illegible]	[illegible]	9.10	.68
[illegible]	[illegible]	[illegible]	7.20	.40
[illegible]	[illegible]	[illegible]	[illegible]	..
[illegible]	[illegible]	807	[illegible]	.73

TABLE II.—SUMMARY FOR ORCHARDS OVER 5 YEARS OF AGE.

[illegible]	Number of orchards	Total acres	Total acre-feet	Acre-feet per acre
[illegible]	1	15	[illegible]	.55
[illegible]	1	[illegible]	[illegible]	[illegible]
[illegible] Mesa	[illegible]	70	71.34	1.02
[illegible]	[illegible]	6	0	....
Yucaipa	3	29	61.61	2.12
San Timeteo Canyon	2	35	14.40	.41
[illegible]	[illegible]	[illegible]	[illegible]	..
[illegible]	[illegible]	154	[illegible]	.38
[illegible]	[illegible]	[illegible]	[illegible]	1.80
[illegible]	[illegible]	471	663.58	1.41

The average used on 23 orchards representing 807 acres of trees under 5 years is .73 acre-foot per acre and the average for 30 orchards representing 471 acres in trees over 5 years is 1.41 acre-feet per acre. This latter group includes an orchard in the river bottom at Oro Grand, tract No. 1, and the Victor Ranch on the first bench, tract No. 3, which are not representative of conditions on the mesas and for which the duty of water is excessively low. Eliminating these the average for the orchards over 5 years of age with a combined area of 426 acres is 1.07 acre-feet per acre. Most of the orchards in Victor Valley appear to have had insufficient water for vigorous growth and production.

The results for the individually owned orchards are supplemented by figures on the gross duty of water for the areas served by several irrigation systems delivering water principally for deciduous fruit trees as given by Table III. The figures, except for the Banning Water Co., are from measurements. The duty for the Beaumont Land & Water Co. is for 1913, and that for the Lake Hemet Water Co. is an average of several seasons. The duty for the other systems is for 1916.

The Yucaipa Co. delivers to orchards of all ages and the water supply has been adequate. Although the precipitation at Beaumont is high the amount given for the system is considered insufficient for the locality. The duty for the Banning Co. is based on the amount of water available for use, 11 second-feet, for six months. The amount actually used may have been less. This company has a plentiful supply and it is probable that more water is used than is necessary. Most of the Hemet orchards are deciduous but some are in citrus fruits. The trees at Palmdale are young and more water should be used when they become mature. Only about 200 acres of the total area given for the Little Rock district were of full bearing age in 1916 and the amount used in this district should increase in the future.

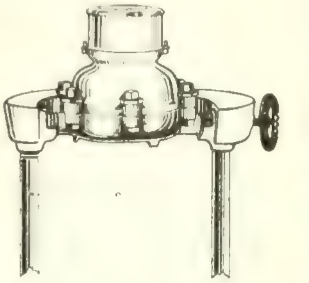
The average amount of water applied under these irrigation systems is .80 acre-foot per acre and the average total, including rainfall, is 1.86 acre-feet per acre. To give the equivalent of this latter amount in Victor Valley it would be necessary to apply 1.36 feet of irrigation water assuming an average rainfall of .5 ft. per annum.

TABLE III.—DUTY OF WATER FOR DECIDUOUS ORCHARDS UNDER IRRIGATION SYSTEMS.

Irrigation system.	Kind of trees.	Acres.	Rainfall in feet.	Irrigation in feet.	Total water in feet.
[illegible]	[illegible] cherries, etc.	2,051	1.50	.53	2.03
[illegible]	Miscellaneous deciduous	1,065	1.66	.12	1.78
[illegible]	Miscellaneous deciduous	2,700	1.10	1.47	2.57
Lake Hemet Water Co.	Deciduous and citrus	5,600	1.00	1.10	2.10
[illegible]	Pear	200	.50	.75	1.25
[illegible]	Pears	1,500	.60	.85	1.45
[illegible]			...	.80	1.86

Meter Yokes

A simple and convenient meter yoke that does not require an expert to install has been brought out by the McNutt Meter Box Co., Box E-3, Brazil, Ind. The method of installation is as follows: Cut out for 9-in. centers, cut risers so as to bring dial of meter to about 4 in. below lid of cover, screw on the elbows for yoke, line them with the eye, place meter and yoke with gaskets in place, turn hand wheel reasonably tight, turn on water, if there is a leak turn your pipes slightly with wrench so as to remedy leak. The yoke is furnished with leather gaskets ready to install. The same firm also has brought out a meter yoke for basement installations where it is desired to place the meter on the vertical pipe. This yoke will take any standard ⅝-in. meter or a ⅝ meter with ¾-in. spuds. It has no screw connections in any way. Cut out 2 in. of pipe, to read ends, screw on the ells, and the meter is ready to set.



U. S. Employment Service Opens New Offices for Its Professonal Section.—The United States Employment Service has further extended the scope of its work by the establishment of two new zone offices of the Professional and Special Section, in Philadelphia and Boston, and it plans to establish other offices of this section in the near future. The new zone offices are in addition to the two main offices at New York and Chicago, and will serve the particular zones in which they are located. Employers requiring the services of educated and experienced men, are asked to state definitely th nature of the positions available, to the nearest of the following U. S. Employment Service Professional and Special Section offices. New York office, 16 E. 42d St.; Chicago, 62 E. Adams St.; Philadelphia, 1518 Walnut St.; Boston, 16 Tremont St.

General Factors Affecting the Cost of Constructing Hydro Electric Development

The Public Utilities Commission of Maine, during the past season, conducted a special investigation of water power and water storage matters in that state. In connection with this work the commission employed Mr. H. K. Barrows, Consulting Engineer, Boston, Mass., to report upon the cost of development of water powers and of electrical energy. The matter following is extracted from Mr. Barrow's report.

The first cost of a hydro-electric plant is likely to be greater per horsepower than that of the steam electric plant, although with favorable natural opportunities for water power development this may not be true.

The manner in which a water power is developed, as well as its cost, depends largely upon what may be called "the natural conditions," such as the amount of fall in the river, its degree of concentration, the size of the river or amount of water available for power, the availability of good foundations for a dam and the character of the topography adjacent to the river, with particular reference to the economical location of canals and penstocks.

Where fall is well concentrated and conditions of flowage permit, the simplest and most economical method of development is to build a dam with the power house at one end (or sometimes in the dam itself), simply utilizing the fall developed by the dam. For heads up to the vicinity of 30 ft. such development can be made with the turbines placed in open wheel pits. Above this amount of head the cost of the bulkhead walls is likely to be such that a more economical development is made by bringing the water through short penstocks (or pipes under pressure) to the wheels. Frequently natural conditions are such that it is more economical to carry the water in a canal or closed penstock for some distance along the river below the dam, rather than to obtain the full fall by means of the dam. This is likely to be the case where there are limitations to the height of the dam on account of resulting damage due to flowage.

Whether or not such development will be made by means of a canal or penstock depends largely upon the size of the river, viz., the amount of water to be carried. For a large stream (perhaps for quantities of flow in excess of 500 or 600 cu. ft. per second) it is usually more economical to use a canal, for the necessary size of penstock required increases quite rapidly with the quantity of water to be carried and the cost of very large penstocks is relatively much greater than for smaller ones.

With large rivers, however, it is often desirable on account of the topography of the river banks to carry the water the greater part of the distance in a canal with small slope, and then for a short distance in penstocks (usually one for each wheel unit) which drop rapidly from the canal level at its end or "fore bay" to the wheel units at the level of the power house.

The main features of a hydro-electric development may therefore be divided into (1) Dam. (2) Waterways—either canal, penstock or a combination of these. (3) The power house, including its foundations and tailrace. (4) The equipment, which may be further sub-divided into hydraulic and electrical.

Obviously the general items which will most affect the cost of a water power development are those of the dam and waterways. Where natural conditions are such that these features of the development can be made at low cost, the resulting total cost of development will be low, as in general the other features (power house and equipment) will vary in cost within a comparatively narrow range.

Cost of Hydro-Electric Developments in the State of Maine.—The average total cost per horsepower of plants at developed sites on six rivers in the state of Maine, is about $114 per horsepower, which is the roughly estimated reconstruction cost of hydro-electric plants at the various sites where power has been developed (at many of which of course the power is now being used for other purposes). This estimated cost is for a development based on the flow available 60 per cent of the time, after regulation, with 100 per cent load factor.

The cost per horsepower of a hydro-electric plant will vary materially with the basis for power considered, as well as with the point in the development up to which costs are included.

The estimate made of the cost of constructing plants at undeveloped power sites on six rivers in Maine show an average cost for the four principal rivers of $99 per horsepower on the same general basis as that previously stated. The average cost of all plants—both developed and undeveloped—is $107 per horsepower.

The cost of individual plants will vary very greatly from these figures—from about $60 per horsepower as a minimum up to $250 or more where sites are not especially good or conditions of development difficult. These are normal or pre-war costs. Present costs would be probably more than double these figures.

Effect of Load Factor on Cost of Development.—We may logically include the cost of dam (including land and water rights) and waterways (and perhaps of power house foundation and tailrace, if these are features of importance or of unusual construction) in an item which may be called "Construction cost" and which reflects particularly the relative advantage or disadvantage of the power site. The remaining costs, which may be called "Power House and Equipment," will obviously vary almost directly with the extent to which development is made, or more particularly the load factor for which the plant is designed.

To indicate the general extent to which load factor affects the first cost of plant, Table I has been prepared:

TABLE I—EFFECT OF LOAD FACTOR ON COST OF HYDRO-ELECTRIC PLANTS

Cost of plant to deliver 1 HP. on wheel Shaft with different load factors.						Per cent increase in [illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible] PH [illegible]	Other [illegible]	Tot[illegible]	L. F. Total [illegible]	L. F. Total [illegible]	L. F. Total [illegible]	[illegible] L. F.	[illegible] L. F.	[illegible] L. F.
(1)	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

In the foregoing table the two approximate extremes in cost of development in the state of Maine have been assumed, with the usual variation in cost of equipment and power house. In a general way a power development which costs $200 to $250 per horsepower to develop is likely to be on a large stream tending to a moderate or low head development, under which condition the cost of equipment and power house is likely to be at a maximum, as well as the features of construction. For this case, therefore, the range in cost of equipment and power house has been taken from $25 to $10 per wheel horsepower.

Similarly, a low cost of development at $60 per horsepower is likely to be a high head development, with usually a moderate amount of water. This tends toward lower cost of equipment and power house, and the range here has been assumed from $20 to $25 per horsepower on the basis of 100 per cent load factor.

The relative costs of such plants with varying load factors are given in columns 4 to 6, inclusive, of Table I, and in columns 7 to 9, inclusive, the per cent increase in cost over that for a load factor of 100 per cent. It will be noted that for the upper limit in cost of development of $250 per horsepower, the per cent increase in total cost due to the load factor being other than 100 per cent with a 30 per cent load factor. With the low cost plant assumed at $60 per horsepower this increase in cost is about 10 per cent for an 80 per cent load factor and 80 per cent to 100 per cent for a 30 per cent load factor.

The cost per horsepower of wheel capacity of hydro-electric plants will be less as the load factor decreases, as the increase in cost of plant with lower load factor is offset by the greater relative increase in wheel capacity.

The variation in total cost with load factor is, as would be expected, much greater where the cost of the plant is low, as the variable factor of cost of equipment and power house is a much greater percentage of the total cost.

With a load factor of from 50 to 60 per cent, which may be expected for conditions in the state of Maine, the cost of plant may therefore be increased from about 15 per cent to 40 per cent over that for a load factor of 100 per cent.

Cost of Water Rights.—The cost of water rights (including usually land required for development) must of course

[illegible]

[illegible] of Maine [illegible] evidently [illegible] as noted [illegible]

Cost of Power from Hydro-Electric Plants.—Fixed charges [illegible] 10 per cent [illegible]:

Interest ....5— 6%
[illegible]
Total [illegible]

[illegible] items of which are wages and repairs, are low. These will naturally vary materially with the capacity of the station and with load factor. They [illegible] hour of power deliv[illegible] hydro-electric plants with a load factor of approximately 50 per cent.

Assuming annual fixed charges at 10 per cent, their cost per k. w. hour for 24-hour 365-day power has been computed [illegible] first cost and load factors as given in the previous table:

[illegible] PLANTS WITH [illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
60	20	0.10	0.11	0.13	0.18

The above represents the chief item of cost of hydro-electric power at the switchboard. The remaining item of operating cost, as previously noted, will not usually exceed 0.10 ct. per k. w. hour. It will be less with large plants and high load factors and greater for the converse of this situation.

A hydro-electric plant on the rivers considered would not deliver its full output for 40 per cent of the average year. [illegible] from 70 to 80 per cent of the full output on these rivers, with the suggested storage regulation, so that only about 5 per cent less tha nthe full output would result, for the average year. Making this slight deduction and keeping in mind 50 to 60 per cent load factor, as was assumed for future steam plants, it is evident that hydro-electric power can be delivered at the switchboard for from about 0.25 ct. to 0.60 ct. per k. w. hour, for the range of cost of developments found on the rivers discussed in this report.

Cost of Transmission Lines.—Much progress has been made in perfecting power transmission and lines over 200 miles in length with a voltage of 150,000 are now in use. The longest line at present in this country, near Los Angeles, is about 240 miles long.

The following discussion upon transmission lines, with table of estimated costs for different lengths of line, capacity, voltage, etc., has been prepared by Professor Ralph G. Hudson of the Massachusetts Institute of Technology.

An economic study of transmission lines for the state of Maine indicates the superiority of the steel tower line over any other type of construction and the estimates presented are therefore based upon steel tower construction. A comparison of steel tower lines and wooden pole lines for long distance high-tension heavy power feeders reveals little difference in the first cost. It may be said that the first [illegible] is naturally associated with many [illegible]. The average [illegible] cedar [illegible] years and when located in marshy [illegible] sometimes be replaced in less than [illegible]. If the poles are impregnated with preservatives such a creosote, the life may be lengthened to 30 years, but such preservation materially increases the cost of the poles and certain soils have been found to be highly absorptive of the preservative materials.

The steel tower line while costing no more than the wooden pole line under heavy power conditions and attended by a smaller maintenance charge, possesses many other distinctive advantages. The life of a steel tower of the windmill type under proper maintenance is seldom less than 50 years. There will, therefore, be less cause of interruption of service by reason of replacements. If the towers are painted every three years they will withstand all climatic causes for deterioration for a considerable period and are invulnerable to every other cause, including forest fires. Steel towers are furthermore unaffected by an ordinary stroke of lightning, while wooden poles are usually shattered. This point is of exceptional importance in its bearing upon the continuity of the power service, since the steel tower not only withstands strokes of lightning but serves to conduct the lightning to ground and thereby affords considerable protection to the transmission line itself.

The character of steel tower construction makes possible the use of longer spans than are practicable with the wooden poles. The length of span employed in steel tower construction ranges from 400 to 800 ft., while with wooden pole construction the length of span rarely exceeds 200 ft. Among the many advantages of the long span transmission line is the smaller number of insulators required in comparison with the short span lines.

In estimating the cost of the various transmission lines, a size of line wire was determined in each case which would give a minimum annual cost of operating the line; that is, the interest, depreciation and tax charge per year was made equal to the annual cost of the electric energy lost in the line wires. In all the calculations leading to the final estimates pre-war costs were assumed throughout.

The line voltage suggested for each of the typical transmission lines is high enough to make the power lost in transmission comparatively small. Among all the cases cited in the estimates of first cost the power lost in heating the conductors will range from 2 to 4 per cent of the total power transmitted. In most of the lines the total cost will be divided between the cost of conductors and the cost of the towers, including erection and right of way. In the case of short low-power lines the total cost may be divided in the proportion of two-thirds for the towers and one-third for the conductors, while in the case of short high-power lines employing a single line of towers the total cost may be divided in the proportion of one-third for the towers and two-thirds for the conductors.

Owing to the many advantages possessed by the suspension type of insultor in high-tension service all estimates have been based upon the employment of that kind of insulator

In the following tables are given the estimated cost of steel tower transmission lines per mile for different lengths, capacities and voltages; also cost of river crossings and annual operating costs of transmission lines. A load factor from 40 to 50 per cent has been assumed in the computation of this table:

ESTIMATED COST OF TRANSMISSION LINES

Distance [illegible]	Capacity of line (k. w.)	Line voltage	Number of tower lines	Number of wires per tower	Total cost per mile
[illegible]	[illegible]	66,000	1	6	$ 3,500
[illegible]	[illegible]	66,000	1	6	5,000
[illegible]	[illegible]	66,000	1	6	7,000
[illegible]	[illegible]	66,000	1	6	5,000
[illegible]	[illegible]	66,000	2	6	10,000
[illegible]	[illegible]	100,000	2	6	14,000
[illegible]	[illegible]	100,000	2	6	14,000
[illegible]	[illegible]	150,000	2	6	20,000
[illegible]	[illegible]	150,000	2	6	20,000

COST OF RIVER CROSSINGS

[illegible]	[illegible]	Line voltage	Number of tower lines	Number of wires per tower	Total cost per crossing
[illegible]	[illegible]	[illegible]	1	6	[illegible]
[illegible]	[illegible]	[illegible]	2	6	15,000
[illegible]	[illegible]	[illegible]	[illegible]	6	[illegible]

[illegible] COST OF TRANSMISSION LINES

[illegible]

Interest 7

[illegible]

Cost of Transmitting Power. In the following table is given the total cost, cost per kilowatt transmitted and the annual cost per kilowatt hour for the different lines assumed by Professer Hudson

ESTIMATED COST OF POWER TRANSMISSION

Length of line, miles.	Capacity of line, kw.	Total capital cost of line	Capital cost per kw transmitted (L. F. and 5% losses).	Cost per kw hr (with annual cost 25% of first cost)
25	5,000	$ [illegible]	[illegible]	0.1[illegible]
25	10,000	125,000	26	0.08
25	20,000	[illegible]	18	0.05
50	10,000	250,000	55	0.15
50	25,000	500,000	42	0.12
50	50,000	700,000	29	0.08
75	50,000	1,050,000	[illegible]	0.13
75	100,000	1,500,000	32	0.09
100	100,000	2,000,000	42	0.12

The above table shows that power transmission at a cost of about 0.10 ct. per kilowatt hour or less is readily obtainable. Also that power to be transmitted most economically over long distances must be in large amounts. Thus, with a 50-mile line the cost per kilowatt hour with a line of 50,000 k.w. capacity is only about one-half that where the capacity is but 10,000 k.w.

Cost of Storage Reservoirs.—The average estimated cost of constructing storage reservoirs upon six rivers in Maine is about $33 per 1,000,000 cu. ft. of storage capacity—a low figure which reflects the unusually favorable opportunities for storage development to be found in this state.

Storage on the Presumpscot River has already been developed and the extremely low cost of $10.79 per 1,000,000 cu. ft. of capacity has been made possible by the great natural storage facilities of Sebago Lake.

The following data shows the cost for storage reservoirs in other localities:

Reservoir.	Purpose of storage.	Cost.	Capacity, mil. cu. ft.	Cost per mil. cu. ft.
CONSTRUCTED.				
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Power	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] River, New York	[illegible]	[illegible]	[illegible]	[illegible]
Wachusett, Mass.	*	11,021,353	8,760	1,269
[illegible]		[illegible]	[illegible]	[illegible]
ESTIMATED.				
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Power	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Saranac Lake, New York	Power	614,000	4,000	154
Harrisville, Oswegatchie R., N.Y.	Power	696,000	5,000	139
Black Lake, do	Power	580,000	6,000	97
[illegible] Rapids, do	[illegible]	[illegible]	[illegible]	

*Water supply.

Cost of Operation and Maintenance of Storage Reservoirs.—The cost of operation of storage includes the wages of men employed in operating gates and in general supervision, ordinary repairs and the cost of keeping records of the height of reservoir, flow from reservoir, etc., which required some engineering supervision. The total annual cost would include also, of course, items covering interest on investment, taxes and insurance.

The principal item of first cost is usually that of the dam, and with permanent concrete construction the rate of depreciation is low. The fixed charges, including interest, depreciation, taxes and insurance, would be about 9 per cent per year, and usually a further allowance of 1 per cent would cover charges for operation and maintenance.

Through the courtesy of Mr. Walter H. Sawyer, data in regard to the cost of operation and maintenance of storage reservoirs on the upper Androscoggin River have been furnished. In the case of the Rangeley Lake system with a total storage of about 18.5 billion cubic feet, operating expenses and repairs for the period 1902-1913, inclusive, average a little under $10,000 per year or about 52 ct. per million cubic feet of storage capacity. Since 1911 additional storage capacity afforded by the Aziscohos dam has been utilized. Furthermore, the dam at Pontocook has also been used for storage regulation. The total storage capacity in use in these two years has been about 28.3 billion cubic feet, and the average cost per million cubic feet for these two years was about 97 ct.

Meter Practices of the Hackensack Water Company

By [illegible]

Testing Meters. [illegible] of the Hackensack Water Co. [illegible] from the manufacturer [illegible] follows: a [illegible] cu. ft. test on full flow, a [illegible] cu. ft. test on a ½-in. stream, and a 0.1 cu. ft. test on a 1/32-in. stream. The complete test for a [illegible]-in. meter is a 10 cu. ft. test on full flow, a [illegible] cu. ft. test on [illegible]-in. stream, a [illegible] cu. ft. test on [illegible]-in. stream and a 0.1 cu. ft. test on 1/16-in. stream. The complete test for a [illegible]-in. meter is a 100 cu. ft. test on full flow, a 100 cu. ft. test on 1-in. stream, a 10 cu. ft. test on [illegible]-in. stream, and a 10 cu. ft. test on [illegible]-in. stream. For a 6-in. meter the tests are a 100 cu. ft. test on full flow, a 100 cu. ft. test on 1-in. stream, a 10 cu. ft. test on [illegible]-in. stream, and a 10 cu. ft. test on 5/32-in. stream. For an 8-in. meter the tests are a 100 cu ft. test on full flow, a 100 cu. ft. test on 4-in. stream, a 100 cu. ft. test on 2-in. stream, a 100 cu. ft. test on 1-in. stream, and a 100 cu. ft. test on ½-in. stream.

The records of all tests include the change gears used with each and every meter. Before the ½-, ¾- or 1-in. go into service, a separate test is made by the water company, and no meters of these sizes are installed which do not show an inaccuracy of from 1 to 2 per cent against the water company. The ½-, ¾- and 1-in. meters are also subjected to a water pressure test of 350 pounds per square inch by means of a hand pump.

In making tests often required by customers because of high bills, such meters are considered accurate if tests show them to be within 2 per cent either way.

The author feels that he cannot emphasize too strongly the importance of testing carefully all meters which have been frozen. His experience has been in [illegible] of cases that the disc chambers or, in the rotary piston type of meters, the top head of bottom plate, or possibly both parts, were so badly sprung that merely replacing the bottom casting does not restore accurate registration. It is agreed that because a meter freezes this does not belittle it in any way, although it may cost more to repair some makes than others. Yet there is no good reason why meters can not be protected from frost, and freezing is almost invariably due to lack of consideration or negligence [illegible]. In such cases the expense of repairs should be borne by the owner of the premises.

Meter Setting.—All meters used in connection with the Hackensack [illegible] [illegible] deposit is required to cover the cost of repairs. After this cost is known the balance is returned to the owner of the premises.

Prior to Jan. 1, 1918, applications for service were made by about 200 plumbers licensed by the water company. After the service main was installed and the building was ready for occupancy, the meter was delivered to the plumber and set by him. Since Jan. 1, 1918, the water company has been setting all meters and the plumbers no longer have anything to do with this part of the work. When the meter is set, a shut-off cock is placed on each side of it and a check valve is also located on the house side of the meter, which acts as a protection to the meter as well as a protection to the property of the owner, should a break occur in the street main.

Only a small percentage of the meters are set in outside meter boxes, and such settings are confined almost entirely to manufacturing plants and private fire lines. Suitable concrete boxes are required for such outside settings, and built at the expense of the applicant.

In manufacturing plants, where the use of water is large [illegible] it advantageous, both to the consumer and itself, to install the meters in batteries, which, of course, adds to the expense, but enables examinations, repairs or changes to be made without interruption to the service.

Meter Reading. All meters on the system, of which there are about 45,000 in use, are read and billed quarterly, except about 300 in sizes between 1½ and 10 in., which are read and billed monthly. Meters registering more than 25,000

[illegible]

[illegible] All [illegible] day of the [illegible] in [illegible] on the following day.

In reading the quarterly meters, the districts are divided [illegible] territory [illegible] about [illegible] on the [illegible] and must be com[illegible]

[illegible] starts out with about 200 cards on which read[illegible]tered, and each card, by using both sides, pro[illegible]ch quarterly readings for a period of four years. [illegible] afternoon, together [illegible] and all complaints, such as meters not working, broken glasses, meters leaking, etc., all of which receive attention on the following day. Printed cards are also mailed on the day following the reading to all customers where the meter shows an increased or unusual consumption. [illegible] the quarterly bills.

[illegible] the reading period it is plain that on the day following the last reading day, all defective-reading meters have been changed, that the many various small complaints have been attended to, that the bills have been made out, and there has been ample time for comparisons, checking, etc., before the end of the month. During recent years the company has not failed in getting into the mail during the last day of the quarter the entire survey bills, which are then in the hands of its customers on the first day of the following quarter.

Collection of Bills, etc.—Promptly after the bills reach the customers, payments begin to come in, and an accurate record and report of collections is made by each district office and tabulated at the main office, showing each morning the sum of money collected in each district and its percentage relation to the survey.

In following any such plan, an excellent opportunity is afforded for comparing the work of the various collectors.

During recent years the records show that about 65 per cent of the total surveys are collected during the first 30 days, and from 26 to 30 per cent during the second 30 day period.

Maintenance of Meters.—For many years the Hackensack Water Co. has been following the practice initiated in the early nineties of removing for test and a general going over, the various sizes of meters after having registered a fixed quantity of water and regardless of the length of time required to reach these quantities. The practical result is that every meter installed on the system comes into the shop at about uniform intervals for a general overhauling. After examination, repair, test and painting, the meter is returned to stock and is ready for another period of use. Following this practice, a very small percentage of meters breaks down, and the author is sure that a higher degree of efficiency is maintained between the intervals of fixed registration.

For more than 20 years the company kept up its original plan of making these changes, as follows: Change all ½-in. meters after registering 100,000 cu. ft.; change all ¾-in. meters after registering 250,000 cu. ft.; change all 1-in. meters after registering 500,000 cu. ft.; change all 2-in. meters after registering 2,000,000 cu. ft. In sizes above ½-in. records were kept of all examinations, including examinations of intermediates, and changes were made when it was deemed necessary.

All such changes are now made under the rules, regulations and recommendations of the Board of Public Utility Commissioners for the state of New Jersey, which are as follows: Change ½-in. meters each 10 years, or after registering 750,000 cu. ft.; change ¾-in. meters each 8 years, or after registering 1,000,000 cu. ft.; change 1-in. meters each 6 years, or after registering 2,000,000 cu. ft.; change all meters larger than 1-in. each 4 years.

All work in connection with the testing, repair or maintenance of the meters is performed in the water company's shop, which is complete with up-to-date tools and modern testing equipment, and seven or eight men are steadily engaged on this work.

Mosquito Control in Ponds by Means of Fishes

Early in 1918 the U. S. Commissioner of Fisheries, in response to a request from the U. S. Public Health Service for an ichthyologist, detailed Samuel F. Hildebrand to cooperate with the public health authorities of the extra cantonment zone of Camp Hancock, Augusta, Ga., in an anti-malarial campaign. The duty assigned to Mr. Hildebrand was an investigation of the effectiveness of fishes as eradicators of the aquatic stages of the mosquito, and the conduct of such operations as would promise secure "fish control" in many ponds and small lakes where control by oiling was impracticable. The top minnow (Gambusia affinis) was selected for the tests and the investigation was confined almost wholly to the determination of the practical value of this fish in anti-malarial work. The results of the investigation have been set forth by Mr. Hildebrand in a preliminary report to the U. S. Commissioner of Fisheries, from which the following notes are abstracted.

The top minnow was selected for the tests because: first, it seeks its food at the surface, which appeared to make it especially suitable for anti-mosquito work; second, it lives and thrives under a large variety of conditions and especially in water suitable for the support of mosquito larvae; third, it proved to be quite common in the extra-cantonment zone and adjacent territory; fourth, it is very prolific; and fifth, its usefulness in destroying mosquito larvae in aquaria and fountains was already known.

Means and Methods Employed in Stocking Ponds with Fish.—Minnows for stocking ponds were secured mainly from two sources; first, from swamps within the protected area which were being drained; and second, from waters outside of the extra-cantonment zone, from places where minnows did not appear to be needed. Large numbers of minnows were secured from these sources and placed in ponds where few or none were present.

One pond, about 100x30 ft., with an average depth of about 3 ft., was used as a "hatchery." This pond has a very muddy bottom and it supports much alga and several attached plants. All fish were removed from this pond. About 3,000 female Gambusia were placed in the larger compartment. No record was kept of the number of males which were introduced, as this is relatively unimportant, but there were probably not more than 10 to each 100 females. The purpose of dividing the pond into two compartments, using a ¼-in. wire screen for a portion of the partition, was to give the young fish an opportunity to migrate to that section of the pond where they could not be followed by the adults. This was thought advantageous, because of the cannibalistic habit of Gambusia. The ¼-in. mesh, however, proved to be a little too large and some of the adults succeeded in getting through it. The reproduction in this hatchery, nevertheless, exceeded all expectations. This pond, being conveniently situated, furnished a ready supply of top minnows for aquaria, fountains, pools, and wells, wherever they were found to be needed or as requests for them were received.

A very useful net for collecting top minnows is a small bobbinet seine. The one used was about 12 ft. long and 3 ft. deep. Such a net if made of a good grade of netting, is light and durable, and it can be quickly and easily handled. A dipnet, also made of bobbinet, was used to some advantage in places where there was so much vegetation that a seine could not be operated.

Results Obtained from Introducing Minnows into Mosquito Breeding Places.—On April 1, mosquito larvae of the Culex type were found in a ditch, in several pools and in a large pond. These waters were all free of debris and vegetation. The pond had steep shores and it was very clean. It was one of the newer brickyard ponds and no fish were present. All of these places, being close together, were stocked with Gambusia at the same time. Only 6 fish were placed in each of the pools which were about 10 to 12 ft. long, about 2 ft. wide, and very shallow. Each pool supported thousands of mosquito larvae, but in about two weeks they were made entirely free of wrigglers by the fish and remained so until they became dry later in the season. The presence of comparatively few skins showed that not many of the larvae reached the adult stage. The ditch referred to was approximately 30 ft. long and 1 ft. wide. Mosquito larvae were especially abundant in it. About 200 top minnows were placed there and in two weeks it was completely free of wrigglers. Mosquito larvae were seen only along the shore of the big pond. It was at first stocked with about 1,500 Gambusia, but later several thousand more were added. The larvae in this pond, too, disappeared in about two weeks from the time the first fish were introduced and none were again seen until September. By that time the shores had become overgrown with vegetation which furnished protection for Anopheles larvae against fish. This vegetation was cut and the shores were raked. A large school of top minnows followed the workmen, destroying the immature mosquito and other insects as quickly as their hiding places were destroyed.

It was possible, in several instances, to connect ditches and swamps which were thickly infested with mosquito larvae with ponds that were well supplied with top minnows. Wherever this was done, large numbers of fish entered these waters and destroyed the mosquito larvae in a surprisingly short time.

For the purpose of comparison and as further evidence of the value of Gambusia in controlling mosquito breeding two other small ponds are worthy of mention. These ponds are situated at the intersection of the tracks of the Georgia Central and the Belt Line railroads and they are of about equal size. The top minnow had reached one of the ponds from an unknown source, and it was entirely free of mosquito larvae. The other was without fish and mosquitoes were breeding in it in abundance. The inference, in the absence of any evidence to the contrary, of course is that the top minnows destroyed the mosquito larvae in the first pond.

During the later part of October two new brickyard ponds were found to be breeding large numbers of mosquito larvae. The ponds had become supplied with some vegetation, but the mosquito larvae were not confined to these hiding places, but were quite generally distributed over the ponds, and could be seen in perfectly clear water. Anopheles larvae previously had been noticed only once away from all protection, and then as now in a pond not stocked with fish. On Oct. 23 about 1,000 Gambusia were placed in one pond and the other was left as a control. On Oct. 26 no pronounced reduction in the number of larvae in the pond which had been stocked was noticeable. On Oct. 29, however, a remarkable decrease was evident, only a few larvae being left, and these were found in vegetation. At the end of this time the immature mosquitoes in the other pond, (control) were as abundant as ever.

Many similar experiments and observations could be mentioned, but as the results for all were nearly identical it is not advantageous to do so. It then may be stated that wherever mosquitoes were breeding prolifically Gambusia was not present, but if introduced mosquito breeding was eliminated or at least greatly reduced. Wherever the complete elimination of mosquito larvae did not result, if sufficient top minnows were present, the immature mosquitoes were so protected by vegetation or debris that they could not be detected or reached by the fish.

Aquatic Plants and Mosquito Control.—It is evident from the study of plants in relation to mosquito control by means of fish, that it is highly desirable to remove those plants having leaves just below the surface of the water, from ponds, and to treat algae in such a way as to make them useless as protectors of mosquitoes. The presence of these plants was by far the most important obstacle to be overcome in securing mosquito control in the many ponds in the extra-cantonment zone of Camp Hancock. A rather constant vigilance is necessary in order to keep a large series of ponds free of such plants, but it is not very difficult work or usually very expensive, for two laborers, provided with hoes, rakes and knapsacks, spray can, and some oil, can take care of quite a number of ponds during the course of a season. In badly infested ponds it is occasionally advantageous to cut the vegetation with a patented device, known on the market as submarine saw.

Conclusions.—Gambusia affinis is especially suitable for anti-mosquito work because: (a) It seeks its food at the surface; (b) it is very prolific; (c) it gives birth to well developed young, therefore requiring no special environment for depositing and hatching the eggs; (d) it lives and thrives under a large variety of conditions and frequents areas especially suitable for the support of mosquito larvae; (e) it usually lives and multiplies in ponds stocked with predaceous fishes, providing it has very shallow water for refuge.

Plants which have slightly submerged leaves and stems or which form floating masses are the chief sources of protection for mosquito larvae against the top minnow. Such plants should be removed from the water or treated in such a way as to make them uninhabitable for the immature mosquito.

Mosquitoes may breed in water so badly polluted that Gambusia is almost instantly killed thereby.

Gambusia affinis is of great value in anti-mosquito work. It eliminates the wriggler completely from ponds which are fairly free of protective vegetation and debris. If much protection is furnished by vegetation and debris the immature mosquito is not entirely eliminated, but the number reaching the adult stage is greatly reduced.

The number of top minnows necessary in a body of water in order to secure mosquito control depends largely upon the conditions which prevail with respect to places of protection, i. e., a much smaller number of Gambusia is necessary, if the water is fairly free of hiding places for mosquito larvae against fish, than if the reverse is true.

Factors Requiring Special Consideration in Hydraulic Fill Dam Construction*

By C. E. GRUNSKY.

The hydraulic fill dams already in use sufficiently demonstrate that the construction of dams by the hydraulic fill method has merit. Such accidents as happened to the Necaxa dam in 1909 and to the Calaveras dam in March, 1918, should not be allowed to discredit the method. They serve, however, in giving some definiteness to the limitations to which the method is subject and to the precautions which must be taken to insure a safe structure. The fact that in both of these cases the tops of these dams were at heights of 150 to 200 feet, when the slides occurred, may be accepted, moreover, as good evidence that the construction of high dams by this method is feasible. Probably in neither of these cases would there have been any failure if the progress of erection had been slower, if more time had been allowed for the unwatering of the material of which the dams were being built.

It is obvious to any engineer who has reflected on the problems connected with the serviceability of earth dams that the presence of a certain amount of finely divided material, of which clay is typical, is essential as a component part of the finished earth embankment and that the ideal disposition of this material would be throughout the mass of structure with preponderance at points near the up-stream face so that any moisture that may penetrate through the up-stream portion of the structure will find less and less resistance to its passage as it approaches the down-stream face.

The ideal is more readily obtainable when the method of construction is dry fill than when it is hydraulic fill. The hydraulic fill method of construction requires that provision be made to confine the water with which material is floated into place long enough to let this material settle. There must consequently be barriers erected which will pond the water on top of the dam.

The ordinary practice is to place these barriers along the up-stream and down-stream edges of the top of the dam and let the sluiced material be discharged along these barriers. The coarse material will by this process be dropped nearest to the upstream and down-stream faces of the dam and the finest, ultimately densest material will be crowded to the center. In the extreme case in which there is scarcity of fine material it may be advisable to deliver only along the down stream barrier in order that the finest material may be crowded as far toward the up-stream face as possible, thereby establishing the condition of greatest density up-stream and greatest perviousness near the down-stream face. From this condition to the other extreme of excessive amounts of clay there may be all manner of gradations.

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*[illegible]

[illegible]

[illegible] the pocketing of [illegible] too long [illegible] such a case [illegible] the siltier material [illegible] a selection in the [illegible] at each successive [illegible]

[illegible] imperviousness of an earth dam is not [illegible] readily imagine a dam, for example, constructed of material graded from coarse to fine but without clay in which the fine material in well compacted mass is near enough to the up-stream face and far enough from the down-stream face that it not only sufficiently checks the movement of moisture through the structure but also gets adequate support from the coarser material. Such a dam, on a suitable foundation, may, even with some leakage, be a perfectly safe and useful structure. [illegible] can not approach the down-stream face. There will be no danger of sloughing, provided of course that proper slopes have been adopted and saturation does not result from other causes such as excessive rainfall upon improperly drained surfaces.

The draining out of the moisture to the surface of the clay mass while a dam is under construction and water [illegible] both downward and horizontally outward to the surface of the mass. The clay mass begins to dry, in other words, from the outside. It shrinks in drying, thereby facilitating the movement of moisture from the interior toward the surface of the mass. This movement is the result of the forces of capillarity and of gravity.

The greater the dimensions of the wet mass the larger will the amount of water which must move from the interior to the outside through the outer layers of the mass and therefore the longer will the outer layer be kept wet and the slower will be the rate at which consolidation takes place. The presence of clay in the material of which a [illegible] the rate of construction and perhaps, too, the height of the dam that under consideration of all circumstances could be recommended for construction by the hydraulic fill method.

[illegible] component part of a dam may be ascribed in large part to its property of swelling when absorbing moisture. A fairly dry compact mass of clay is exceptionally well suited to resist percolation. When its surface is wet as when water rises against a dam, it is probable that this property of swelling with resulting interior pressure prevents deep penetration of the water and accounts for the fact that, in the case of dams composed in part of clay or constructed with good clay puddle cores, absolute imperviousness can so frequently be claimed. But the drying of the clay to a reasonable degree of consolidation and compactness is necessary to put the clay into the condition in which it will properly perform its function and as a general proposition this condition should be obtained before drying is checked by submergence of one face of the dam as when a reservoir is brought into use too soon.

More information is needed relating to the effect of depth of deposit of wet clayey material on the unwatering of the lower layers. Is the upward progression of consolidation due solely to the decreasing rate at which water will flow downward through added depth of material as distance from the ponded water on the top of the dam increases? Or does the weight of the superincumbent material assist in pressing out the water from a confined mass of clay? And what is the relation of the rate of unwatering to depth [illegible] the horizontal distance from the sides of the [illegible]?

Answers to these questions when they can be given will be of material service in defining the limitations which are [illegible].

Without endeavoring to make the enumeration complete it may be suggested that among the factors which require special consideration, when the hydraulic fill method of constructing an earth dam is being studied are the following:

1. The suitability of the available material to make a practically water-tight dam when floated into place with water.

2. The relative cost of the hydraulic fill dam when compared with the cost of a dry fill dam.

3. The quality and relative amount of the fine material.

4. The physical properties of the fine material particularly in the matter of giving up the moisture of saturation when accumulated in large masses.

5. The possibility that throughout the mass of the dam local rates of drainage and consolidation will be variable, which may result in so pocketing saturated masses of material that drying out these masses would be retarded.

6. The difficulty of ascertaining the degree of consolidation at all critical points.

7. The interference with drainage and consolidation by the use of the dam for the storage of water before consolidation is complete.

8. The probable settlement that will result from the shrinkage of drying clays.

9. The time required to construct and make available for use.

With reference to the construction of earth dams by the dry fill method it need only be said that when the foundation is suitable and materials are available the only limiting factor is cost.

There will be many cases, particularly in the West, where the suitability of the material for the construction of a hydraulic fill dam is unquestioned. When this is so the main factor to be considered will be the relative cost of the two methods of construction. Because this is occasionally decidedly in favor of the former it has made this type of earth dam deservedly popular.

Enough has been said to show that the difficulties of construction by the hydraulic fill method and the uncertainty of what is taking place in the matter of consolidation must increase with the volume of the deposited material. Consequently the problem of determining the method of construction becomes more difficult and grows with importance as the height of the dam increases. It becomes increasingly so when the proportional amount of clay is large and the consolidation will be correspondingly slow.

The use of the hydraulic fill method of constructing earth dams necessarily has its limitations. These limitations can not be defined other than in general terms. Each separate case presents its own problems. In this respect the hydraulic fill dam is on a par with other types of dams introduced at a comparatively recent day, but which have demonstrated their serviceability—such for example as the multiple arch dam—but which also have their limitations. The hydraulic fill dam has already made a place for itself. That this place will be more definitely delineated as further results of experience become available, goes without saying. It is too soon to say that the method is not suitable for any height of earth dam yet proposed.

Water Consumption at Hartford, Conn., in 1918.—The total consumption of water at Hartford, Conn., in 1918, as recorded by master meter, was 4,175 million gallons, or an average daily draft of 11,436,000 gal. per day. This is accounted for approximately as follows in the last annual report of the water commissioners:

	Per cent	Equivalent in gallons per day
Paid for at rate	[illegible]	[illegible]
Flushing [illegible]	0.1	10,000
[illegible]	0.4	45,000
Street sprinkling and flushing	[illegible]	[illegible]
Fire extinguishing	0.2	20,000
Unaccounted for, waste, etc.	[illegible]	[illegible]
Total	100.0	11,436,000

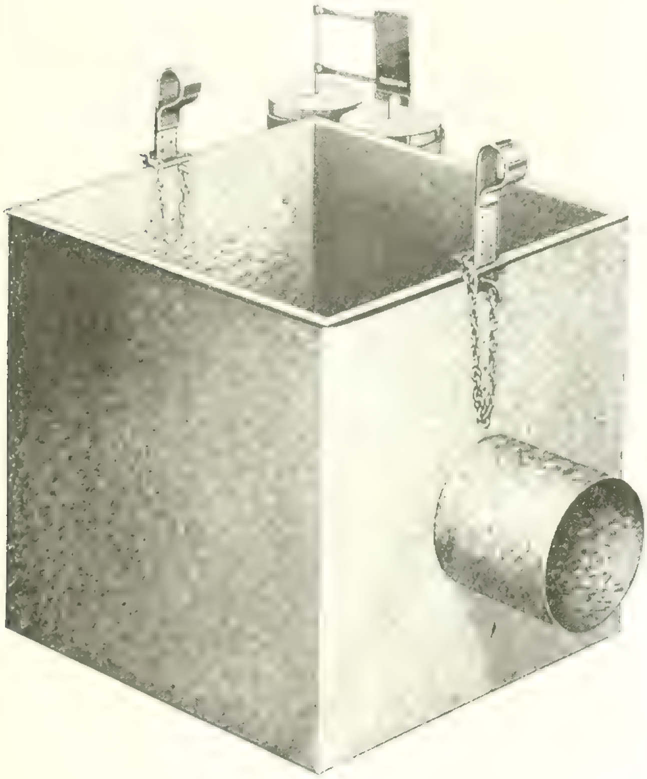
The waste and unaccounted for water on the basis of consumers represents the equivalent of 13 gal. per capita per day.

Combination Tap Box and Measuring Device for Metering Irrigation Water

A combination headgate and measuring device for measuring the flow of irrigation water delivered to the farm unit, that is being used extensively in irrigated sections of the United States is illustrated. The device is known as the Burnham submerged orifice. It consists of a rectangular opening made of metal in which the vertical height does not exceed one-third of the horizontal width, and an orifice which is adjustable as to size vertically but not horizontally. The patented adjustable feature is a decided advantage over the old style of a fixed orifice as it gives the device a wide range of delivery with a minimum loss of head. One of the principal advantages of the orifice lies in its ability to accurately measure and deliver large or small quantities of water with comparatively little loss of head.

In order to give accurate results the orifice must at all times be completely submerged, such submergence to be of sufficient depth as to overcome any appreciable "boil" or "whirl" below the opening. This condition is automatically produced in the Burnham device by having the main control gate placed outside of, and at the correct elevation with reference to, the orifice and all water has to pass through the orifice before being released by the gate. When installing the combination head-gate and measuring device it is so placed in the canal bank that the bottom of the opening is slightly below the bottom of the canal thereby giving it the advantage over the ordinary weir installation of being able to draw a normal head of water with an extremely low head in the main canal.

The device is made in several different sizes, for instance, the No. 3 size has an opening 2 ft. in width and adjustable in height from 1 in. to 6 in. The maximum capacity for accurate delivery, using this size, is 3 second feet; the effective head, or loss of head, being $4\frac{1}{2}$ in. The minimum flow for the same size is one-fifth of a second foot with an opening 2 ft. wide by 1 in. high and a head of $\frac{3}{4}$ in. The next size larger is No. 5, which has an opening 3 ft. in width adjustable from 1 in. to 8 in. in height. A discharge of 5 second feet is obtained through this device with a pressure of $3\frac{1}{8}$ in. and a minimum of 1.5 sec. ft. with a pressure of $\frac{3}{8}$ in. The No. 8 size has a range from 1/5 sec. ft. to 8 sec. ft. The average farm unit does not require a delivery of over 3 sec. ft. and therefore the No. 3 size is, perhaps, the one most commonly used though the No. 5 is a very popular size on some projects.



Burnham Submerged Orifice.

Another distinctive feature of the Burnham device is the arrangement of the "float wells," or "stiiling boxes"; one compartment being connected with the water above the orifice and the other with the water below.

The wells are provided with metal floats which are so arranged as to mechanically differentiate the difference in head between the upper and lower sides of the orifice and the floats are in turn provided with an indicating arrangement which gives the effective head or indicates directly the proper discharge in miners' inches or second feet without computation, the result being easily read by the canal rider or water user.

Installation of Measuring Device

The sheet metal part of the Burnham gate is made of American ingot iron. For permanent installation the gate is usually reinforced with a concrete collar or cut-off wall and a sufficient length of corrugated culvert pipe is used to extend to the outer edge of the canal bank. Care should be taken in the installation to provide a pool at the entrance, or at least, to guard against a velocity of approach in excess of 0.5 ft. per second.

Some of the advantages claimed for the above combination as manufactured by the Utah Corrugated Culvert & Flume Co., Woods Cross, Utah, are as follows:

1. It is a combination headgate and measuring device in a fairly compact arrangement and properly proportioned.

2. It accurately measures comparatively large or small quantities of water with a minimum loss of head.

3. It approximately proportions the flow of water to the individual user in cases of canal fluctuation.

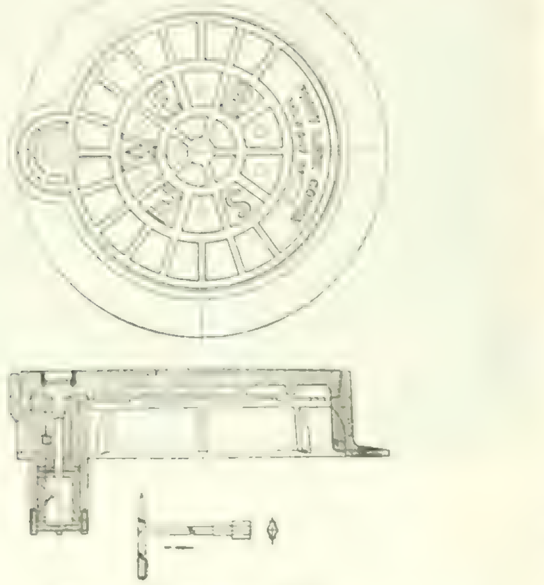
4. The correct flow is readily ascertained by the water user as well as the canal rider and disputes are therefore avoided.

5. The orifice will give accurate results in all cases where other forms of wells are commonly used and [illegible] in many cases where the ordinary [illegible] be used.

1919 to Be Big Garden Year.—Home gardening is starting off this year in every section of the country with the momentum gained during the two gardening seasons in which the [illegible] reports to the garden specialists of the United States Department of Agriculture [illegible] States. According to these reports gardening has spread to [illegible] in city and suburban as well as rural life. With experience gained by amateur gardeners in past seasons and with gardens assuming a permanent rather than a temporary character [illegible] corded in making waste land produce food.

Manhole Cover with Self Contained Locking and Operating Mechanism

A manhole cover [illegible] cannot be [illegible] or tipped from its frame by traffic is illustrated. This device has a locking mechanism by means of which it is firmly locked to its frame. A shoulder is cast at the manhole frame to hold the [illegible] and supports the operating pivot bolt and cover [illegible]. A sleeve centered [illegible] cast to the cover, and is [illegible] inside the housing and rest on [illegible] having at its base a cam or helix which [illegible] with the [illegible] the bottom of the housing and the upper part [illegible] the sleeve. A water-tight [illegible] passing through the cover with a further [illegible] extension which fits into a square core in the top of the pivot-bolt, operates the pivot bolt. By means of the key wrench which has a handle about 2 ft long the pivot-bolt is turned independently of the sleeve and cover, and rides on the lower cam plate, unlocking and raising the cover from its frame for clearance. At this point in the operation the pivot-bolt, sleeve and cover are automatically locked by the weight of the cover in the same relative position, and any further movement of the key wrench and pivot-bolt thereafter rotates the cover and pivot-bolt together. In closing the cover it is swung by a clockwise rotation of the pivot-bolt back to a position directly over its seat. This manhole cover is manufactured by L. A. Ransehousen, Springfield, Mass.



Pivot Lock Manhole Cover.

Mosquito Control in New Jersey Would Cost $750,000.—In an address at the annual meeting of the New Jersey Mosquito Extermination Association, held last month at Atlantic City, Dr. Thomas J. Headlee, State Entomologist, stated that it would cost $750,000 to free the state from mosquitoes. He said that already established methods of drainage had been applied to more than 100,000 of the 326,000 acres of breeding marsh in the state. He estimated the annual cost of maintenance following eradication through approximately 70,000,000 ft. of ditching at $103,800 or 35 ct. per acre, the greatest part of which would be required for keeping open the drainage ditches in the reclaimed area.

Cold Weather Increases Water Consumption.—Due to abnormal weather conditions in the winter of 1917-18 the average daily water consumption of Hartford, Conn., increased above normal about 1,000,000 gal. daily during January, and 1,750,000 gal. daily during February. The average daily rate of flow during the year increased gradually from 11.26 m. g. d. in March, 1917, to 13.08 m. g. d. in February 1918. Except during the extremely cold weather of December, 1917, and February, 1918, when the night rate (midnight and 4 a. m.) reached 420,000 gal. per hour, a rate of about 250,000 gal. per hour was maintained throughout the year.

Personals

George Byars has been appointed city engineer of Waco, Tex., [illegible] J. Wercrow, who resigned recently to engage in [illegible].

Patrick J. O'Brien, member of the Board of Public Works of [illegible], N. Y., has been appointed superintendent of Section 1 of the Oswego Barge Canal.

Patrick J. Cawley of Syracuse, N. Y., has been appointed deputy superintendent in charge of the middle canal division of the New York State Barge Canal system.

J. C. McVea, heretofore office engineer of the City Engineer's Department of Houston, Tex., has been appointed city engineer, succeeding [illegible], who resigned to engage in engineering work in New York City.

C. C. Wallace, formerly manager of loading of munitions section of the Stereotype Co., Indianapolis, Ind., is now director of development and service of the Powdered Coal Engineering & Equipment Co. of Chicago.

F. C. Williams, formerly acting office manager for the Miami Conservancy District, Dayton, O., but more recently superintendent of the drainage operations at Hamilton, has resigned and will be identified with the James Ferry & Sons' Co. of New York contractors.

Richard T. MacCracken, first sergeant of Company A, Forty-second battalion, Twentieth Reserve Engineers, has been awarded the distinguished service medal by Gen. Pershing. Prior to his enlistment he was identified with the Department of the Interior as engineer of the bureau of national parks.

Col. Paul S. Reinecke, during the war commander of the 211th Regiment of United States Engineers at Camp Meade, has arrived at Galveston and assumed his duties as assistant to Col. Spencer [illegible], chief engineer for the Galveston district. Col. Reinecke served with his command until the Eleventh Division was mustered out.

Capt. A. U. Wetherbee, who recently received his discharge from the Chemical Warfare Branch of the service, and who was formerly chief engineer and assistant works manager of the Niagara Alkali Co., has accepted a position as chief mechanical engineer with the Powdered Coal Engineering & Equipment Co. of Chicago.

George T. Prince, district engineer of the U. S. Housing Corporation, in charge of utilities connected with building projects in New England, will open consulting engineering offices shortly at Omaha and Denver. Mr. Prince up to July 1 last was chief engineer of the Metropolitan Water District of Omaha. He resigned that position to accept service under the U. S. Government.

Industrial Notes

G. P. Blackiston has resigned from the Koppel Industrial Car & Equipment Co. of Koppel, Pa., after having been with the company for nearly 12 years in capacity of advertising and promotion of sales manager.

Walter A. Zelnicker, president of the Walter A. Zelnicker Supply Co. and affiliated companies in St. Louis, has appointed Cline B. Finnell as his private secretary. Mr. Finnell, who recently returned from the Officers' Training School at Camp Pike, Ark., was formerly traveling secretary to the general superintendent of the C., B. & Q. R. R. and later private secretary to Clarence H. Howard, president of the Commonwealth Steel Co. Mr. Finnell is president of the Junior Chamber of Commerce of St. Louis, an organization of 1,000 members of younger business men of the city.

C. W. Johnson has been appointed assistant manager of works of the Westinghouse Electric & Mfg. Co. Graduating from Ohio State University, Mr. Johnson entered the employ of the Steel Motor Co. of Johnstown, Pa. A year later he became associated with the Bullock Electric Co. of Cincinnati, O., and in 1904 was made superintendent of the Allis-Chalmers-Bullock, Ltd., of Montreal, Can. In 1907 he entered the employ of the Westinghouse Co., being appointed chief inspector of works, later being promoted to general superintendent, in which capacity he has served until his recent appointment.

The Fishel & Marks Co., iron and steel merchants, Cleveland, are now putting up a new yard at 71st street and Krakow avenue, Cleveland. The yard will cover 11 acres and will have five tracks accommodating 150 cars at one time. The equipment will include six shears, an Acme hydraulic press for sheet scrap, three overhead cranes on concrete runways with 75-foot spans, each span 360 feet long with magnet attached. There will also be twelve acetylene outfits; wagon, truck and railroad scales with weighing capacities of 15 tons, 30 tons and 200 tons, respectively, three steel stiff leg derricks with magnets attached, each unit having 50 tons lifting capacity, and a locomotive crane with magnet.

The Dayton-Dick Co. of Quincy, Ill., has changed its name to the Dayton-Dowd Co. The change was made owing to changes in organization. Capital has been doubled and the business placed directly under the control of those immediately interested. Facilities are greatly extended. The company has recently received many orders for large irrigation and drainage pumps, and it can now build any size from 1¼ in. to 30 in. in a split casing type of pump. It has developed a complete line of fire pumps, complying with specifications of the various underwriters' boards. Furthermore, it has developed high pressure and hydraulic pumps for boiler feed, elevator pumps and similar high pressure service, and these lines are to be pushed to the utmost.

Trade Publications

The De Laval Steam Turbine Co., Trenton, N. J., has issued a 32-page catalog describing standardized geared turbine units for marine service. The new publication describes the details of construction of turbines and gears and also various turbine-driven auxiliaries, including lighting sets, circulating pumps, boiler feeders, etc.

The Ingersoll-Rand Co., New York, has issued a 12-page catalog on its high speed piston valve steam engine, class "FP." This engine is of the horizontal center crank type, and the steam valve is of the most approved design, permitting the use of the highest steam pressures and superheated steam. Catalog also contains cross-sectional illustrations showing the machine in detail.

"Chlorine Control Apparatus for Water and Sewage Purification" is the title of a 64-page book brought out recently by the Wallace & Tiernan Co., Inc., 349 Broadway, New York City. This book is more than a catalog of apparatus; it is a real treatise on the science of chlorination. It contains information of value to every engineer interested in water purification and sewage treatment.

Railways and Excavation Monthly Issue

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Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power

Railways and Excavation—3rd Wednesday
(a) Excavation and Dredging
(b) Rivers and Canals
(c) Quarries and Pits
(d) Railway Construction Steam and Electric

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbors Structures
(d) Miscellaneous Structures

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The Cost of Appraising the Railways and the Worth of That Cost

It is estimated by the director of valuation of the Interstate Commerce Commission that the field work of appraising the railways will be finished by the end of this year and that the office work will be finished a year later, at a total cost not exceeding $20,000,000. This is the cost to the Government. Since much of the work is being duplicated by the railway companies, the cost to all concerned may possibly amount to nearly twice $20,000,000. As a matter of fact, up to date, the cost to the railways has been only one-third of that of the government.

However, taking merely the $20,000,000, we have a cost of approximately $1 per $1,000 of capital outstanding—stock, bonds and notes. It is likely that the cost of reproduction will not differ greatly from the capitalization, or twenty billion dollars. An appraisal cost of $1 per $1,000 of property is low where a very careful inventory is made. Even were it $2 per $1,000 the cost should not be regarded as excessive.

The editor conducted a valuation of a very large telephone plant at a cost of $3 per $1,000 of physical property. That may perhaps be taken as the maximum where a detailed inventory of a large plant consisting of many small units is involved. At the other extreme of valuation cost may be taken the editor's appraisal of the railways of Washington, at a cost of 25 ct. per $1,000 of physical plant. In the latter case, nearly all quantities were derived from office and accounting records, thus reducing both the field work and the office calculations to a minimum.

There are about 255,000 miles of railway line and 395,000 miles of track in America. Hence, if the railway appraisal costs $20,000,000, it will amount to $80 per mile of line or $50 per mile of track. It is interesting to note, in this connection, that railway surveys usually have cost about $250 per mile of located line.

From time to time many railway officials have expressed opposition to the expenditure of money for railway valuations. During the war this opposition was particularly aggressive. It was argued that since every effort should be made to win the war, all work on railway appraisals should cease. As late as Oct. 10, 1918—just a month before the war ended—one of our contemporaries published an article by a "former general manager" of a railway, summarizing the arguments against what seemed to him to be a further waste of money in valuing the railways. He began by saying that four years had passed since the valuation work was started, and that even after the two remaining years of that work had come to an end, it would take 20 years for the courts to settle all the questions involved. He said:

"The cost, estimated by the director of valuation at $20,000,000 for the completed work, has been estimated by competent engineers as likely to reach $50,000,000 before the final results are secured. The railways are, independently in many instances, making complete valuations, largely duplicating the work of the commission and the cost of the work. The cost of litigation to determine the value finally will add enormously to the expense, so that the estimate of [illegible] be excessive.

"The question as to the real value of this work has been argued pro and con for years. That it has some value is evident, but that value lies chiefly for purposes such as taxation, entirely outside of the original intention of the commission, which was to determine the matter of reasonable rates of transportation."

[illegible] with his statement that the valuation will have no utility [illegible] the Interstate Commerce Commission's findings as to values.

the Supreme Court will [illegible] settle all important questions within a year or so after they are raised. At any rate that has been the history of such cases in the past.

That the appraisal will be useless for ratemaking purposes no unbiased engineer is likely to contend if he has had much experience in rate cases. Courts and commissions have almost without exception asked for appraisals of railway and utility plants where a general system of rates [illegible] had to be considered. The Supreme Court itself, in the Smyth vs. Ames case, has named the cost of reproduction as one of the factors in a rate problem. But even were courts and commissions disposed to ignore valuations, there [illegible] be warranted.

The public believes that nearly all railway and utility companies are capitalized greatly in excess of the property cost. At bottom it is this well nigh universal belief that accounts for most of the public opposition to rate increases. If the public can not be convinced that it is mistaken, then Government ownership will come. To convince the public that it is mistaken, there are only two ways, first to secure an unbiased and complete audit of accounting records from the beginning to date, so as to show actual cash investments; second, to present an unbiased appraisal. The first of these methods is not always applicable. Railway officials usually say that it is never applicable, save in the case of a relatively new plant. Even where accounting records are complete from the start, a periodic inventory of plant is needed to check the plant accounts. Hence, no matter how viewed, an appraisal is necessary.

An appraisal cost of $2 per $1,000 of property is only one-fifth of 1 per cent. Fluctuations in market values of railway securities are frequently several per cent in a single day. When billions of dollars are at stake one is indeed myopic who can see only the cost of an appraisal without seeing the enormously greater value of the appraised property.

"Fordizing" the Electric Railways

About seven years ago, during the hearing of an electric railway rate case, the editor testified that a heavy depreciation annuity should be provided to cover the "functional depreciation" of rolling stock. He pointed out that improvements in design and changes in capacity of street cars had occurred almost continuously, and that the future could be judged only by the past. At that time there was no great change in street car design in sight, but the editor felt confident that some important development would occur.

At the present time there is occurring a great change in street car construction. The heavy type of car is giving way to a smaller, and very much lighter model. These smaller cars are frequently "one-man cars," the motorman acting as a fare collector.

Interurban electric railways are almost universally equipped with heavy Pullman type cars; but this type of car seems also slated for the scrapheap at an early date. The Cincinnati, Lawrenceburg & Aurora R. R. is now using 12-ton interurban cars in place of its former 25-ton cars, with a resulting reduction of more than 50 per cent in the current required for operation. The old, heavy car consumed 3.56 kilowatt hours (at the station bus) per car-mile as compared with a consumption of 1.7 kw. hrs. plus 10 per cent for light and heat for the lighter car. By the installation of current meters on the cars the current consumption has been further reduced about 10 per cent.

These light interurban cars seat 40 people, attain a speed of 40 miles an hour and cost about $8,600 complete.

Commenting upon this innovation, "Electric Traction" recently said:

"While there were at first a number of skeptics concerning the advisability of the use of light-weight cars on an interurban road, there has been nothing in the operation of this line to sustain the objections. Rather, there has been displayed an appreciation of the operating efficiency and economy, which is gratifying to the management and those responsible for the revolutionary changes. The men in track and roadway departments are enthusiastic over the change and it is optimistically predicted that the adoption of the scheme will go a long way toward eliminating the handicap of a shortage of track laborers, as it is claimed that the track will require less than one-half of the labor formerly required to keep it in shape for the heavier cars. The entire scheme may be said to be to the electric interurban lines, what the introduction of the Ford car was to the automobile industry; or the introduction of the one-man car to city lines. There is the distinction here, however, that schedules, speed, and seating capacity have not been reduced in the least and that the line is capable of, and is actually handling more traffic than previously."

A very pretty point is raised as to the rate making valuation that should be assigned to a railway property after a change like this has been made. Clearly the value of the plant as an operating property is enhanced by any such improvement, yet the cost of reproducing the plant in use may be actually reduced considerably. Shall the owners of such a property be penalized by a rate commission because they have installed a newer and better plant? Justice answers "No," but many an appraiser still answers "Yes."

Why Wages of Railway and Public Utility Employes Should Be Fixed by Public Commissions

Labor unions have always opposed laws providing for compulsory arbitration of issues between them and their employers. Employers, for the most part, have been equally insistent upon their alleged "right" to effect their own settlements of difficulties with employes. The result is that the general public is compelled to suffer serious loses and inconveniences during every strike of public utility and railway employes.

At the present writing 141 towns and cities in Northern New Jersey are without street car service, because the Public Service Ry. Co. and its 4,500 employes can not agree as to wage rates. A complete tieup of all the subway, elevated and surface car lines in New York is imminent, because a strike of the harbor workers has cut off the fuel used to generate electric power.

It is safe to say that if the car lines in New York City were to cease operating a few days, the resulting aggregate loss to residents of New York would be many fold the entire amount at stake in the controversy between the harbor workers and their employers.

Such conditions as these are rapidly crystallizing public opinion in favor of compulsory arbitration of wage matters wherever public transportation is involved. The Interstate Commerce Commission and the state railway and utility commissions should be vested with power to fix not only rates charged for railway and utility services, but wages paid employes.

Civil engineering societies should endeavor to secure this extension of the regulatory powers of these commissions. No organized effort is being made toward this end, yet it is evident that the time is rife for action.

Is Compressed Air Used Extensively Enough on Construction Work?

Although electric power is ideal where rotary motion is produced, it is not very satisfactory where reciprocating motion is desired. Thus, for drilling, tamping and the like, compressed air or steam is preferable to electricity. Compressed air is also suitable for use in driving rotary tools or machines, such as augers, hoisting drums, etc. Hence there is a very wide field of usefulness for compressed air, a wider field than is generally realized by construction engineers and contractors.

Portable compression plants driven by gasoline engines are already used extensively, but for every one now in use there should be a score or more. There is rarely a large construction job on which a portable compressor would not prove profitable. To enumerate only a few of the uses of such a plant will serve to indicate its general applicability. Thus, there is: Ramming or tamping of concrete, earth backfill, ballast, etc.; drilling with hammer drills, piston drills and rotary earth augers; boring wood for bolts and driftbolts; hammering drift bolts and spikes; adzing and dropping timber; cutting pipe threads; toothing out paving brick and chipping the mortar from old brick; operating small hoists, swinging derrick booms, etc.; riveting; operating grindstones, small saws, etc.; pneumatic painting and sandblast cleaning.

With wages 50 to 100 per cent higher than they were five years ago, there is greater need than ever to use labor saving machines and devices. Compressed air tools furnish an admirable means of reducing labor costs on construction work.

An Overwhelming Vote Against the Piece Rate System

Opposition of labor unions to the ordinary piece-rate system has been in evidence for many years. That this opposition is proving effective is well illustrated in the following news item:

"Piece work in the shops of the New York Central, Pennsylvania, Norfolk & Western, Philadelphia & Reading and Burlington will be abolished by Feb. 15 or March 1. This is the result of a referendum by all the men. As 85 per cent of all shopwork on the Pennsylvania was on the piece system and about the same on the New York Central this will work a great change in those shops. About 90 per cent of the men voted for the abolition of the system and in favor of substituting the time basis."

Every student of economics knows that some form of payment in proportion to performance should be adopted wherever practicable. It is not difficult to persuade the average workman that his wage should rise as his output increases. Then why is it that a referendum by the shopmen of the three railways above named resulted in a rejection of the piece-rate plan by a vote of nine to one? A correct answer to this question is of very great economic importance.

The majority of workmen are fearful that any increase in wage consequent upon the adoption of a piece-rate plan will eventually be taken away from them by a lowering in the rate per piece. In a nutshell, that is the usual reason for opposition to piece-rate and bonus systems. It seems likely that this opposition will persist until the Government itself steps in to protect workmen. While most employers are fair in making piece-rate schedules, there are some who are not fair, and these unfair employers have brought piece-rate and bonus systems into disrepute among workmen. Moreover, when an unfair employer cuts an established piece-rate, a fair employer who maintains the rate is placed at a great disadvantage in his competition with the unfair employer.

Both employers that are fair and employes that are ambitious have much to gain by Government fixing of minimum piece rates.

The Continued Deficit in Railway Income

When the Government raised the wages of railway employes a little more than a year ago it was stated that, inclusive of the wage increase previously granted to trainmen and enginemen, the total increase would amount to about $500,000,000. Now it develops that a serious error was made in this estimate, for the total wage increase exceeds $800,000,000.

In spite of a 25 per cent increase in freight rates the present net earnings of the railways do not suffice to pay operating expenses and ordinary interest on the invested capital. Thus, in January the operating ratio was 90¾ per cent, which means that nearly 91 per cent of the gross operating income for January was required to pay operating expenses! This 91 per cent is about the same operating ratio that the Government-owned railways of France showed prior to the war.

Prior to the world war the operating ratio of American railways, averaged about 70 per cent, without including taxes as a part of operating expenses; and the taxes amounted to more than 4 per cent of the gross revenue. This was a poor enough financial showing. Now it is very much worse.

Whether the railways remain under the management of the Government or are returned to the stockholders, it is clear that a greater net revenue must be secured. Since it is not likely that wages will be reduced, there remain but three ways of increasing the net, namely, (1) increasing the rates, (2) increasing the traffic, and (3) decreasing the expense of operation. Doubtless all three of these factors will be utilized in securing adequate net earnings.

Shall Engineers Be Paid Overtime?*

By HALBERT P. GILLETTE,

Editor Engineering and Contracting.

The eight-hour day is practically the standard for employes on public works in America. Labor unions have succeeded in making it almost universal in factories and mines. Nominally, at least, it is now the standard for railway trainmen and enginemen.

Wherever labor unions have secured the eight-hour day, they have also secured provision for payment for overtime work. The question that we are putting to ourselves as technical engineers is whether a labor unionist should receive overtime payment from the same employer who denies overtime payment to those who do not belong to a union? If so, why?

The daily output of men whose main work is with their hands, rather than their minds, bears a somewhat definite relation to the number of hours worked. The daily output of men whose main work is either of a supervisory or of designing nature, bears less relation to the time spent upon it than to the intensity and character of the mental effort. One good idea, the result perhaps of only a few hours' thinking, may eventually effect an economy of thousands, or even millions, of dollars. Hence it is that a designer or a manager who has large problems to solve does not rate the value of his output by the time expended.

Time, of course, is a factor in every effort, whether mental or physical, but a high grade brain may accomplish more for society in an hour than a low grade brain can accomplish in a life-time. It is clear, therefore, that the designer as well as the supervisor of important work ought never to hold himself or be held to a time unit as a basis for payment for services rendered. In fact the tendency of most brain workers of great ability is to overwork themselves. The very joy of accomplishment leads them into unwise expenditure of nervous energy. Such men need a restraining bit rather than a spur.

Between the extremes of purely muscular and purely mental work, there is a great intermediate class of work that calls for both muscular and mental activity, such, for example, as ordinary drafting or operating an instrument like a transit. The men who do this intermediate class of work frequently aspire to advance to a higher grade wherein nearly all their work will be mental and of a designing or supervisory character. Yet so long as they hold positions of a semi-mental, semi-muscular nature, is it just to require them to be oblivious to the length of the working day in the hope that eventually they will be rewarded by advancement to the supervisory class? I doubt it.

It seems to me that there has been altogether too much feeding of young engineers on hopes of future incomes from higher positions. There has been too much appeal to their professional aspirations while asking them to accept less than skilled mechanics' pay.

A man able to run a steam shovel, a locomotive or a lathe efficiently—a skilled mechanic—is really in about the same class as a good leveler or a transitman, so far as purely manipulative skill is concerned, but in a lower class so far as mental training is concerned. Hence for wage purposes, it would surely be reasonable for instrument men in surveying parties to receive at least as favorable wage considerations as skilled mechanics receive. I am, therefore, inclined to believe that technical engineers in subordinate positions should be paid overtime wherever practicable.

This brings us to the matter of drawing a line between "subordinate" and "supervisory" positions. A little thought will show that there is no purely logical dividing line, and that a somewhat arbitrary dvision must be made. A transitman, for example, supervises the axmen, chainmen, "stake artist" and flagman of his party; yet much of his work consists of the mechanical manipulation of his instrument, and the almost mechanical processes of taking notes and making calculations. On the other hand, a structural designer performs much of his most effective work when he is supervising no one; that is, when his brain is working alone on the solu-

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*Paper presented March 1 at the Railroad Organization Conference of the American Association of Engineers.

[illegible] men can [illegible]

[illegible] "supervisory" engineers. Thus, if locomotive enginemen working full [illegible] a month and are paid overtime, then all technical engineers who receive $200 or less per month would be paid for overtime. All technical [illegible] would then be [illegible] no pay for overtime.

[illegible] that may be suggested for overtime payment for engineers and there are practical difficulties in the execution of any plan, but neither objections nor difficulties are insurmountable.

It may be argued that overtime payments are readily applicable to office draftsmen, but not to field surveyors. I fail, however, to see sound reason for letting little difficulties in time keeping or work scheduling prevent the application of an overtime payment plan. When I hark back to my days as a railway surveyor, I hear no discordant note in the suggestion that it would have been comparatively easy to have reported all the overtime of my party every day; and I am quite sure that there would have been no jarring, untuneful sounds from the throats of my party had each man [illegible] for the 2 to 3 hours of his daily overtime work.

Engineers in the higher positions are apt to be unduly influenced against paying any of their subordinates overtime. To begin with, having reached supervisory positions, they like to make a good showing of low costs. I know of one celebrated engineer who estimated that he could keep the cost of engineering on a big project within 3 per cent. He was so anxious to "make good" on his estimate that he lost his sense of fairness toward his subordinates. He held their salaries down to the lowest possible notch. When there was complaint he told them he could easily fill their places, and that the training they were receiving under him was alone worth more than their salaries—the old, old story. Had there been a [illegible] organization of engineers bent upon securing fair salaries, and had the organization threatened to make public to engineers the attitude of this chief engineer, I doubt whether he would have been so keen to keep engineering costs down to 3 per cent of the total.

Although it is not directly germane, it has a bearing on this subject to point out that while the percentage cost of engineering can be kept down by paying inadequate salaries, in the long run this is a very expensive procedure. The total cost of any engineering project depends very largely upon the design, and this, in turn, depends upon the skill, experience and ambition of the designers—not one, but all the designers. When salaries are held down, ambition to excel is apt to wane. When ambition wanes, an engineer either does not do full justice to his task or he seeks a new position where opportunity looks brighter.

American railways have suffered untold losses through failure to pay adequate salaries to employes in the engineering departments. They have driven many of the most able and ambitious engineers into other fields. They have weakened the ambition of many of those who have remained.

I am reminded of the colored soldier in France who was lazily breaking stone for a macadam road. The blows from his knapping hammer were infrequent enough at best, but he paused to rest upon the slightest excuse. A white officer, noticing his exasperating slowness, went up to him and said:

"Say, haven't you any ambition? You aren't down South on a plantation working for a slave driver. You're a soldier fighting for Uncle Sam. Come boy, show some ambition."

"Ambition? What good's ambition? I gets my li'le thirty per, ef I got ambition, an' I gets it ef I ain't."

Engineers may never fall into the utterly ambitionless class because of low salaries, but there is no gainsaying that inadequate remuneration eventually takes some of the "pep" out of nearly any man.

Contrasted with skilled mechanics, most draftsmen and instrument men are badly underpaid. Not only are their daily rates disproportionately low, but they rarely receive pay for overtime work. Aside from being unjust, this, I feel, is an [illegible]

Use of Paper Tamping Bags Saves Explosives in Blasting

Miners, quarrymen and contractors' blasters generally realize the importance of tight tamping and of using proper tamping material. But proper tamping materials are not always available so they use whatever may be near at hand, with the result that more explosives are often used than are necessary, increasing costs, or bringing down less coal or rock than could reasonably be expected from the quantity of explosives used.

For instance, a miner will tamp with coal dust. This does not ordinarily pack well. Clay or loam would be much better, but a miner cannot be expected to go out of the mine for tamping whenever he loads a bore hole; therefore, he uses what he has at hand.

Miners and rock blasters are beginning to appreciate tamping bags made of heavy paper and used in many places as containers for sand, clay, or loam to be used for tamping.

A supply of these bags can be filled and taken into the mine or on the job at the beginning of the day's work. The blaster is thus sure of having a tamping material that will give him maximum breakage at least cost. Their use also saves time when loading bore holes.

Tamping bags are very useful when the blaster desires to make up charges of blasting powder in cartridge form as they usually do when loading uppers or in damp open work. They are much more convenient than clumsily made funnels or cones, for which pieces of newspaper are generally used.

The bags cost but a fraction of a cent each and their use will nearly always save many times their cost because of the saving in explosives or greater breakage from a given charge.

Shrinkage of Earth Embankments

Specific instances of shrinkage of railway embankments were cited in a committee report submitted this week at the 20th annual convention of the American Railway Engineering Association. Information was given regarding 8 embankments between mileposts 540 and 553 on the Atchison, Topeka & Santa Fe Ry. The following tabulation compiled from the report shows the percentage of material required to restore the several embankments to their original width after a lapse of 4 years' time:

	Quantities in fill at completion, Nov., 1911 Cu. yd.	Quantities required to restore fill to original width of 18 ft., Nov., 1915 Cu. yd.	Amount of shrinkage Per cent.
Embankment No. 1	15,762	1,821	11.6
Embankment No. 2	148,582	6,995	4.7
Embankment No. 3	123,680	2,341	1.9
Embankment No. 4	19,067	99	.5
Embankment No. 5	150,852	664	.4
Embankment No. 6	58,605	1,642	2.8
Embankment No. 7	33,962	1,678	5.0
Embankment No. 8	62,207	3,096	5.0

The base of embankment No. 1 was constructed from side-borrow with fresnos. It was topped with wheelers and carts. The material was brown pack sand, gyp and joint clay. The base of embankment No. 2 was also made from side borrow with fresnos and wheelers. It was topped with cars. The material was the same as for No. 1. For No. 3 the base was placed with fresnos; it was topped with wheelers. The material was brown pack sand, gyp and joint clay. Several rains occurred during the period this fill was being placed which accounts for the small amount of shrinkage. The base of No. 4 was placed with fresnos; it was topped with wheelers using gyp and pack sand. The base of No. 5 was placed with fresnos from side borrow; it was topped with machine and wagons. The material was red sandy clay and gyp. Fresnos were used in placing the base of No. 6; it was topped with wheelers. The material was brown sandy clay and gyp. During the time this fill was being put in there were several very heavy rains, which accounts for small amount of shrinkage. The fill for embankment No. 7 was made from side borrow with fresnos; the material was black sandy loam and clay. The fill for No. 8 was made from side borrow, the base being placed with fresnos and the top with wheelers. The material was black sandy loam and brown sandy clay and gyp.

Outfits for Cutting Off Piles Below Water Line

An effective arrangement for sawing off piles under water is employed by Whitney Bros. Co., general marine contractors, Superior, Wis. Their equipment consists of a machine very similar in appearance to a small swing pile driver. Instead of the drop hammer in the leads, there is a 3-in. shaft, which is raised and lowered by the usual hoisting cables. The shaft runs through boxes, which are attached to guides which run up and down the leads according to the depth required. A 12-in. belt drives the shaft which runs from a drum on the hoisting engine. This engine also furnishes power for turning the leads to the position required. A 48-in. circular saw is attached to the bottom of the shaft. The whole equipment is usually mounted on a flat scow, at each end of which is placed a steam winch which furnishes the motive power.

The procedure, for instance on an ore dock foundation, is to start with the leads swung in line with the center of the first row of piling and then proceed the length of the row with the use of the steam winches. The machine is then swung around and the second row is cut off by the same method. Each row in turn is sawed off, it being only necessary to swing the driver the distance required to be in line of the center of each succeeding row.

It has been found that this equipment makes a very accurate cut at depths down as far as 28 ft. The average capacity is approximately 500 piles per 10-hour day. However, on several occasions an average run of 960 piles and over per day has been kept up for two weeks running. The cost of cutting the piles varies, of course, with labor and material conditions. It ranges around 15 ct. to 50 ct. per pile, according to depth.

In extending the ways at the steel ship yards of the G. M. Standifer Co., at Vancouver, Wash., last summer the special outfit shown in the drawing was employed for sawing off the piles.

The launching ways consist of 39 bents of piling of 8 piles each, spread 6-ft. center to center of bents. All underwater bracing was done by divers before starting cut-off operations. At the stage of river at which the work was to be done, the lowest cut-off was some 7 ft. below water level. The two outside rows of piling were cut off by hand on a grade parallel to the required true grade and 7 ft. above it, thus bringing this temporary cut-off at water surface at the lower end. A 12-in. x 12-in. cap was then placed the full length of the way on this temporary cut-off. This cap was fitted with a 3-in. x 4-in. strip on top to act as a guide on which the carriage support was to move. The remaining inner rows of piling were not cut.

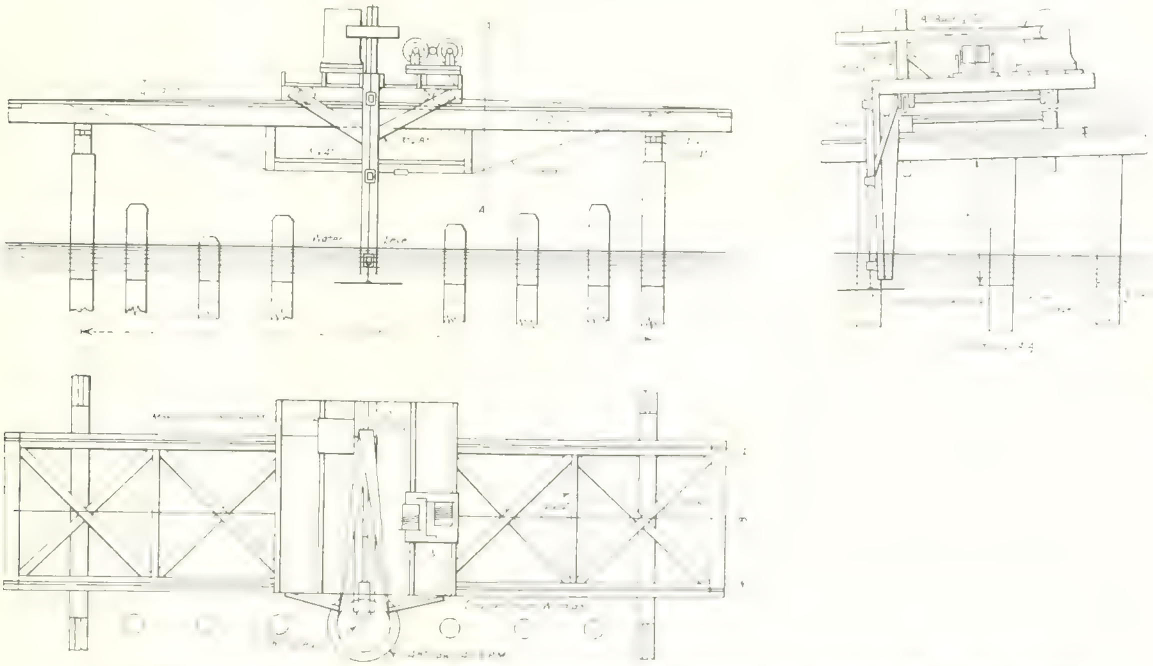
The carriage support consisted of two 10-in. x 12-in. timbers, cross braced 8 ft. apart and fitted with truss rods so as to span the space between the two temporary caps. On these two timbers were fitted 2-in. x 2-in. strips with a 2-in. x 2-in. angle iron to serve as a rail for the traveling carriage. On the carriage was mounted a 25-HP. motor which drove the saw shaft with a quarter-turn belt. The saw shaft was set square with the carriage framing and so varied from the vertical an amount equal to the grade angle.

The 48-in. circular saw was fitted at the lower end of this shaft at the elevation of 7 ft. below the temporary cut-off—that is, so it would cut on the true grade line. A hand windlass with light cable anchored at the ends of carriage support provided means for movement of the carriage transversely. The carriage support was pulled ahead from bent to bent by cable line from a donkey engine on shore.

Whitney Bros. Co.'s Outfit on Ore Dock Job

In operating the saw the carriage was moved to the upper end of the way with the saw on the lower side. The donkey line skidded it ahead along the temporary caps to the first bent. The saw was started in the center space and cut the piling on one side of the center line, being fed through them by the hand windlass. The [illegible] pile was [illegible] cut about three-fourths through on account of its supporting the saw. The saw was then fed through the piling at the opposite side of the center line, and returned to the center ready to be skidded ahead to the next bent. The outside piles were cut the remaining amount by hand after the saw had passed over. Caps were placed in the usual way by divers using block and tackle. The full equipment was easily transferred to the next way.

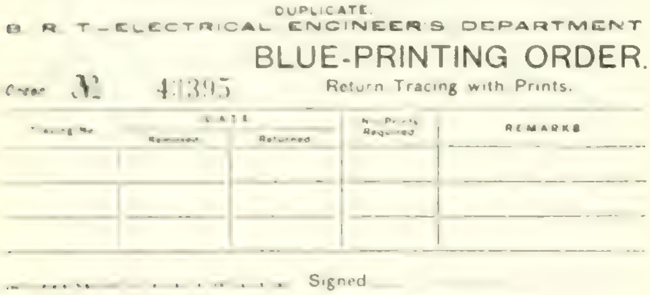
A distinct advantage of the saw cutting was that it preserved a very true and even grade in spite of the small ir-



Cut-off Saw Used by G. M. Standifer Construction Corp. for Cutting Off Piles Below Water Level [illegible] to the [illegible]. The time actually required [illegible] after the preliminary work was done was about two and a half or three hours, one way of [illegible] 1 hour and 50 minutes. Work was carried out under the direction of Tom V. Standifer, Yard Superintendent.

Method of Keeping Records of Blue Prints and Tracings

[illegible] printing for a company is done by one of its departments, there are many opportunities for mistakes to occur before the original tracings, together with the requisite number of blue prints of each, are returned to the department from which they were sent. Either the tracing [illegible] or the prints is delayed in some other manner, or the proper number of prints is not made; or they are returned to the wrong person. All of these mistakes, as well as some more, are liable to occur if the matter is not systematically looked after. To avoid such trouble, writes Mr. G. H. McKelway in Electric Traction, the form shown in the accompanying illustration is used by the Brooklyn Rapid Transit Co. The headings are so plain that there is no need of explaining how the columns are filled out except to say that the total area of the blue print paper used, in square feet, is always put in the column headed "Remarks." This is done because, at the end of the month, the cost of blue printing is divided among all of the departments interested in proportion to the amount of paper used for their blue prints. The forms are made in duplicate and bound into books, each containing 100 leaves, 50 originals and 50 duplicates, and all are numbered. The backs of the original sheets are all coated with carbon so that by merely writing upon the original the same words appear upon the duplicate and without the necessity of interposing a sheet of carbon paper. The original is kept in the book as a record for the department giving the order while the duplicate is forwarded with the tracing or tracings to the department making the prints. After the prints are made they are checked against the duplicate to make sure that the proper number has been made, before the tracing is returned to the department to which it belongs and another check is made there before the prints are accepted.


DUPLICATE.
B. R. T.—ELECTRICAL ENGINEER'S DEPARTMENT
BLUE-PRINTING ORDER.
Order № 41395
Return Tracing with Prints.

Tracing No.	Date Received	Date Returned	No. Prints Required	REMARKS

Signed

Form for Keeping Records of Blueprints.

Fuel Consumption by Tractors.—It takes about 2½ gal. of fuel an acre to run a tractor for plowing in the Dakotas, according to reports from several hundred farmers received by the United States Department of Agriculture. These reports, summarized in Farmers' Bulletin 1035, cover 2, 3, 4, and 5 plow tractors of various makes. Slight differences in fuel consumption are found between machines of different makes, and there is usually a slightly lower consumption where gasoline is used than where kerosene is used. These differences, however, are so small that the average of 2½ gal. may be taken as coming very close to the actual acre consumption for any type or size of machine. The more recent reports received in this regard indicate that farmers are having much less trouble than formerly in handling kerosene-burning tractors. Nearly two-thirds of the tractors on the Dakota farms reporting burn kerosene, and the results are apparently satisfactory, particularly in view of the fact that the present price of kerosene is but half that of gasoline. However, the advantage of gasoline in ease of operation and in the additional assurance it gives that the engine will keep running steadily makes many men prefer the more expensive fuel.

Probable Wages and Supply of Construction Labor During Coming Season

Interesting information on the outlook for construction labor during the coming season was given in a committee report presented last month at the annual convention of the American Road Builders' Association. The committee, of which Mr. Paul D. Sargeant, Chief Engineer of the Maine State Highway Commission, was chairman, made the investigation with a view to determining the probable labor conditions as regards highway work. The results, however, are of such general interest to all engineers and contractors that the report is reprinted below practically in full.

Labor Conditions Succeeding the Close of the Civil War.—The following extract from letter of Charles E. Baldwin, Acting Commissioner of Labor Statistics, under date of Jan. 30, 1919, gives all of the information which the committee was able to secure concerning labor conditions succeeding the close of the Civil War:

> After careful search in the department library we have found no statistics on unemployment as far back as 1866. We did, however, find in Vol. 2 of the "History of Labor in the United States," by Commons, a statement to the effect that "William Jessup in his report to President Whaley, which the latter presented to the convention held in New York, September, 1868, estimated the number of unemployed at one time during the preceding winter at 20,000 in New York alone." Inquiries concerning unemployment were first begun by the census in 1880, but on account of lack of funds and doubts as to the reliability of the returns, the results of this investigation were not compiled. The following statement appears in the First Annual Report (1885) of the U. S. Commissioner of Labor on "Industrial Depressions":
>
> "The year 1867 can hardly be called one of financial panics or industrial depression, although 'hard times' apparently prevailed. The stimulation to all industries resulting from the war, the speculative enterprises undertaken, the extension of credits, and the slackening of production necessarily caused a reaction, and a consequent stagnation of business; but the period was hardly spoken of by business men as one of any particular hardship. People for a while began to be conservative; but the impetus engendered by the war could not be overcome, and it was not until the crash of 1873 that the effects of undue excitement in all branches of trade and business were thoroughly realized."

Survey of Labor Conditions.—A questionnaire was sent out to all state highway departments, to the city engineer of all cities having a population in excess of 100,000, and to many of the large road-building contractors throughout the country. Replies to this questionnaire were received from 39 of the 48 state highway departments, from 54 of the 82 cities to which it was sent, and from 24 road contractors.

The questionnaire asked for information as to the number of hours for a day's work, the rate of pay per hour for common labor from 1912 to 1918 and asked what would be the probable rate for common labor for 1919, 1920 and 1921. Inquiry was also made as to the apparent available sources of supply of common labor for the present season. Suggestions were asked as to additional sources of supply if there did not appear to be a sufficient supply in sight. The committee also asked if state labor exchanges had been used where established and with what result, and concluded the questionnaire by asking for information as to the number of common laborers required for construction work during the season of 1919.

Summary of Replies from State Highway Departments.—Thirty-nine state highway departments made replies to the questionnaire. As some of the departments are only 2 years old their replies were not used in figuring average rates of wages.

In 1912 the average rate per hour as reported by 27 states was $.188, while in the same year Georgia was paying $0.09 and Nevada was paying $.40. Only six states were paying $.25 or more and 10 states were paying $.15 or less—the most of them less. In 1913 the average as reported by 28 states was $.20. In 1914 the same states report an average of $.205, in 1915 of $.225, in 1916 of $.2585, in 1917 of $.303 and in 1918 of $.39. The highest rate for 1918 is reported by Oregon and is $.58. The lowest is by South Carolina and is $.18 per hour.

Twenty-seven states replied to the question as to probable wage per hour in 1919. The average of these replies gives a rate per hour of $.352, which compared with the average of $.39 for 1918 shows a slight decline. Fifteen states think the rate for 1921 will be slightly less than in 1920. The other states do not venture a guess.

Thirty states think labor supply will be more plentiful in 1919, 1920 and 1921 than during the past three years. Twenty of these states give as their reason the ending of the war, with return of soldiers, closing of war industries, munitions plants, stopping of shipbuilding, etc. West Virginia thinks prohibition will put a great many men at work who never worked before. Several states report an over supply of labor now.

Suggestions for additional sources of supply of common labor are as follows: Seven states suggest use of convicts; five suggest importing Chinese and five suggest Mexicans; five suggest general or restricted immigration from Europe. Seven states report sufficient or too much labor now.

Fourteen states have state labor exchanges. Five states have secured labor through these exchanges, but only three report good results. Other reports are as follows: "Not good for common labor"; "Not very good"; "Indifferent"; "Got some labor"; "No good."

Twenty-eight states estimate their requirements of common labor for 1919 as 160,900 men.

Summaries of Replies from Cities.—Fifty-four out of 82 cities replied to the questionaire. Forty-six furnished information as to wages for all years from 1912 to 1918. Taking the year 1912, Spokane, Wash., reports $.37½ per hour, which was the highest, and Birmingham, Ala., with $.14 was the lowest, while the average rate for the year was $.234. In 1913 these 46 cities report an average wage of $.238 per hour. In 1914 the average was $.245; in 1915, $.255; in 1916, $.276; in 1917, $.312; in 1918, $.384. Boston, Mass., reported the highest rate for 1918. It is $.52½ per hour. San Antonio, Tex., had the lowest for the year, $.25, while Atlanta, Ga., and New Haven, Conn., both report a wage of $.28.

The average wage which 48 cities expect to pay in 1919 is $.384, which is the same as the average for 1918.

Forty-two cities expect labor to be more plentiful this year than last and 28 of the cities gave as a reason the termination of war, closing of war industries and return of soldiers. Sixteen cities report plenty of labor now and in sight. Only two cities suggest additional sources. One New York City thinks immigration should not be prohibited, and one California city suggests Mexican labor.

Three cities have secured labor from state labor exchanges with good results; seven have had poor results with such labor.

Thirty-nine cities report that they will need 19,160 laborers during the season of 1919.

Forty-three cities report that they will spend $46,570,613 in highway and street work this season.

Summaries of Replies from Contractors.—Twenty-four contracting firms, well distributed throughout the country, make replies, which may be summarized as follows: The average rate of wages they paid in 1912 was $.192; in 1913 it was $.20; in 1914, $.21; in 1915, $.23; in 1916, $.256; in 1917, $.315; in 1918, $.397. The average wage which they expect to pay in 1919 is $.38.

Sixteen contractors expect labor to be more plentiful on account of cessation of war activities and the return of soldiers.

It is interesting to note that just half of these contractors suggest immigration as the source of further labor supply.

Nine contractors have used labor from state labor exchanges. Six report "poor" results; one reports "bad" results and two state that results were indifferent.

Information from United States Department of Labor.—In the preliminary collection of data for the report the committee ascertained that the Department of Labor, through its employment offices distributed throughout the country, was keeping a close tab on employment conditions, that reports were regularly made to Washington, assembled and published and that beginning soon after the signing of the armistice the number of cities reporting unemployment has been growing weekly. The chairman of the committee had an interview with Mr. Otto T. Mallery, executive secretary of the War Labor Policies Board of the United States Department of Labor. It was learned that this board are rather apprehensive of a serious condition of unemployment. The director of the board, Mr. Harold G. Moulton, had recently delivered an address before the Union League Club of Chicago upon the subject of "Public Works or Public Charity." This address, which has been published, sets forth very concisely the problem of demobilization or equalizing the rate of flow of labor from war activities to peace activities. By a chart Mr. Moulton very clearly illustrated that the bulk of labor at the time the armistice was signed was found in the following reservoirs: Men under arms abroad, estimated to be about 2,000,000; men under arms in the United States, estimated to be about 1,600,000; workers in inconvertible industries; that is to say, munitions factories, possibly 3,000,000 or 4,000,000 of men and women. Supplementing the labor in these reservoirs will be the new immigration, which is problematical, and the natural increase of working population by way of boys reaching maturity.

From all of these sources Mr. Moulton concludes that during the next 12 months it is probable that 5,000,000 or 6,000,000 workers will seek employment in this country.

The problem, of course, is to return these workers to peace time activities in such a way as to avoid a large volume of unemployment, to maintain labor standards, to avoid serious falls in the rate of wages, to maintain production at a high level and to remove the possibility of depression.

As many of the industries which would under peace conditions absorb these laborers were dismantled and refitted for war work, and as many new plants were built in the early months of the war and fitted for war work exclusively and will now have to be refitted for peace-time production, it is apparent that there may be some hiatus in employment, unless perchance public works of a large volume can be provided to consume this labor during the process of transition. Mr. Moulton very properly describes this employment as buffer employment and shows by his chart that the labor upon demobilization from the war activities should flow through this buffer employment and finally be located in peace time activities.

Mr. Moulton points out that we must depend principally on public works, Federal, state and city projects, to absorb this surplus labor.

The War Labor Policies Board has been instrumental in having introduced in Congress a bill, known as the Kenyon bill, providing for the creation of an emergency public works commission, to be furnished with appropriations and authority and at periods of unemployment to assist political subdivisions to carry on local public works by advancing the necessary funds, which would be repaid in installments. During normal times this commision would cease activities.

The state of Pennsylvania passed similar legislation about 2 years ago.

It is interesting to note in a recent report of Mr. Mallery, executive secretary of the War Labor Policies Board, for consideration of the members of the Public Works Commission of Pennsylvania, the following list of activities suggested for providing employment for surplus labor: 1. Highways. 2. Forestry. 3 Water conservation and control. 4. Health. 5. Public works of cities and towns.

Note that highways are placed first. The following explanatory statement is interesting: "Highway construction is particularly useful in providing employment for unskilled workers, upon whom the greatest burden of suffering falls in bad times. The geographical distribution of highway work is another element of advantage for our purpose because it will diminish unemployment in many districts at the same time."

At the conclusion of the interview with Mr. Mallery at Washington he stated to the chairman of the committee very emphatically that the road builders of the country should rest assured that plenty of common labor for all highway construction work should be available during the present season.

An interesting point that was brought out in the interview was the following: Mr. Mallery's attention was directed to the idea, which seems to be prevalent quite generally, that discharged soldiers will not want to take up the work of common laborers. He quite agreed, and stated that discharged soldiers will probably be given work as mechanics and the so-called mechanics, who have been working in munition plants for periods of from three months to a year, will have to go back to the work which they formerly did, namely, common labor. In other words, those who have been employed in the mechanical trades during the last two years will be displaced by returning soldiers.

Press reports to the effect that the House Immigration Committee of Congress has reported a bill which would close against the immigrant for a period of four years the hitherto [illegible] the labor [illegible] and [illegible] country [illegible] of [illegible] and to [illegible] to [illegible].

Emigration. Many foreigners, whom we naturally think of as unskilled laborers, are leaving this country. In the New [illegible] of New York for the lands of their nativity. Nationals of these countries are leaving as fast as ships can carry them. The collector of the port of New York states that there are many [illegible] and [illegible] of February 16,000 Greeks and Italians sailed for their homes. The collector in an interview makes the following statement with respect to these aliens.

[illegible]

The collector's [illegible] with respect to the kind of men who have [illegible] confirms Mr. Mallery's statement that soldiers will take up mechanical work and displace those who have been drawn into this line of work during the war.

Conclusions of Committee. From the reports furnished by state highway departments, city departments and contractors, supplemented by the positive statements by officials of the War Labor Policies Board, and pending legislation to pre-[illegible] unemployment, the committee is forced to the conclusion that there will be a sufficient supply of unskilled labor for highway projects during the coming season and at wages slightly less than those prevailing during the season of 1918.

Ration List for Construction Camps

As the result of an analysis of mess practice in the lumbering industry, made by the engineers of the Spruce Board of the U. S. Army, the following was sugested as a satisfactory ration list for camp messes:

	[illegible] per [illegible] per day.	[illegible] per [illegible] per 90 meals.
[illegible]	1.25	37.50
[illegible]	0.156	4.68
[illegible]	[illegible]	2.4
[illegible]	0.15	7.5
[illegible]	0.05	1.5
[illegible]	0.25	7.5
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	3.75
[illegible]	1.00	30.00
[illegible]	0.10	3.00
[illegible]	0.10	3.00
[illegible]	[illegible]	[illegible]
[illegible]	0.125	3.75
[illegible]	0.062	1.86
[illegible]		
[illegible]	[illegible]	6.00
[illegible]	0.25	7.50
[illegible]	0.031	0.93
[illegible]	[illegible]	27.00
[illegible]	0.10	3.00
Cornmeal	0.02	[illegible]
[illegible]	0.02	0.60
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	7.50
Fresh fruits, etc.	0.25	7.50
[illegible]	0.01	[illegible]
[illegible]	0.071	2.13
Total	[illegible]	[illegible]

Oregon to Vote on $3,000,000 Reconstruction Bond Issue.—At an election June 3, the citizens of Oregon will vote on a $3,000,000 bond issue for reconstruction purposes. The money will be used for public buildings.

Methods and Cost of Driving a 10x12 Ft. Mining Tunnel at Copper Mountain, B. C.

Very rapid progress was made in the driving of the main haulage level at the Copper Mountain Mines of the Canadian Copper Corp., Ltd., near Princeton, B. C. The methods employed in this work were described by Mr. Oscar Lockmund, in a paper presented last fall at the Chicago meeting of the American Institute of Mining Engineers, from which the matter in this article is abstracted.

Conditions were unfavorable for economical operations. The cost of power was high, for the fuel was of poor grade; besides, during the time the work was in progress, very little other power was needed so that most of the power cost was charged against the footage. The transmission line consisted of No. 4 galvanized iron wire with the result that the line loss was considerable. The voltage transmitted was about 30,000. The plant was operated under a lease, which was due to expire about the same time this work was supposed to be completed, an extension was refused; therefore speed was most important.

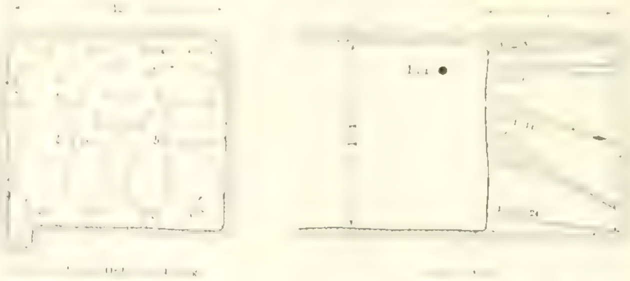


Fig. 1. Drift Round in Main Haulage Lead, Copper Mountain, British Columbia.

The plans called for a straight adit 2,900 ft. in length. At a point 2,800 ft. from the portal, two raises were to be put up to the next nearest workings, a difference in elevation of about 800 ft. One of these was to be a 2-compartment hoistway and the other a zigzag ore pass, or muck run. A location for these raises had been determined by a number of diamond-drill holes, but the material to be penetrated by the adit was not known. It seemed imperative to get the tunnel work completed as rapidly as possible, in order to allow for delays in the raising program, which were certain to occur. To show how closely these operations were timed, it is interesting to note that the date of expiration of the power-plant lease was Sept. 1, 1918, and the last round, making the connection between the upper and lower workings, "broke through" in the night of Sept. 3, 1918.

The plans called for a tunnel 9 ft. high by 11 ft. wide; but owing to the "blocky" nature of some of the rock a considerable "over break" occurred. This enlarged the tunnel cross-section to 10.4 ft. by 12 ft. indicated by measurements taken at 200-ft. intervals after the work was finished and slowed up the work on account of the extra waste handled, besides increasing the cost per foot of driving. Several regions of geological disturbance were crossed and the heavy ground encountered called for timber supports. More than 350 ft. of heavy timbering was necessary at various points along the course of the tunnel; this also retarded the work to the extent of about 6 ft. per day for each set of timber placed. Once the working force was organized and the work well under way, three shifts were put on, working 8 hours each.

The drills used were the dreadnaught No. 60. They were mounted four on a horizontal bar, from which position all but the four bottom holes or "lifters" were drilled, the miners working on the muck pile. Upon completion of the upper part of the round, most of the muck had been removed; that which was left was rapidly thrown back from the face, all hands helping on this work. The horizontal bar was then torn down and dropped to the lower position, from which the lifters were drilled. The change of the bar from the upper to the lower position, together with drilling the lifters, loading, and firing the entire round, was frequently made in 50 minutes. The holes were pointed to pull a 7-ft. round and average about 9 ft. in depth. The center, or "cut holes" were fired first, after which followed the side holes, then the back holes, and finally the lifters. The drift round commonly used in this work is illustrated in Fig. 1, which also indicates the firing of the holes in groups. The blasting was done by hand, the fuses being "spit." The timing of the shots was regulated by cutting the fuse in different lengths; the shortest for the center holes, the next longest for the side holes, and so on. The lifters were loaded with extra heavy charges of powder, so as to throw the muck back from the face as much as possible. This was sometimes helped by placing charges of explosive outside and beneath the lifters; these were called muckers, and were set to go off after the rest of the round had been fired.

The powder used was a non-freezing kind, varying in strength from 40 to 60 per cent nitroglycerin, depending on the hardness of the rock at the face.

The rock was handled in small, V-shaped, hand-dump cars of about 1,000-lb. capacity. Tramming was done by hand until the distance from heading to dump became too great, when horse haulage was substituted; later this was replaced by an electric installation. Steel plates were laid on the bottom for a distance of 30 to 40 ft. from the face, to facilitate shoveling, also to permit shunting empty cars past the loaded trains and thereby eliminating the need for double track.

The cars, being light, were easily pulled from the track and, with bodies tilted, were passed on the steel plates, alongside of the loaded cars and then pushed back on to the track at the muck pile and loaded. Temporary track was laid close up to the face before firing a round. The T-rails were laid on their side, allowing the flanges of the car wheels to run on the grooves thus formed.

The foul air and gases were removed, after each round was fired, by a Connersville rotary blower, of 10 cu. ft. capacity, stationed at the portal of the tunnel. Later, a similar machine was placed about halfway in the adit and worked in tandem with it. The blowers were set to exhaust toward the surface through a 12-in. wire-wound, wooden stave pipe. The men were able to return to the heading within 15 minutes after firing.

The mucking crew was divided into three gangs, on each shift, averaging 11 men per shift. The work was divided so that one gang was shoveling muck, another was picking down from the muck pile, while the third was bringing up empty cars and forming them into trains after they were loaded. This latter work did not take up the entire time, so that this gang had an opportunity to rest. As soon as a train was loaded, the gangs changed jobs; that is, the pickers went at shoveling, the car handlers took the picks, and the shovelers took the easy work, and so on. Greater efficiency was maintained in this manner, as the change of work tended to rest the men and they were able to work continuously.

A bonus system was also a large factor in keeping the men up to the mark. This was based on a daily advance of 9 ft., upon which the then "going" wages were guaranteed; for all advance over 9 ft., $6 per foot was added as bonus. For each set of timber placed, an allowance of 3 ft. was made, which applied on the bonus. Current wages at the time were $4.50 for miners, $4 for helpers, and $3.50 for common labor. The bonus distribution brought these amounts up to $5.91 for miners, $5.25 for helpers, and $4.59 for muckers. The foreman and the shift bosses also shared in the bonus, the distribution being made by pro-rating the bonus in the same ratio as the amount of regular wage received by each man. Everybody seemed satisfied and no difficulties were experienced as far as the labor situation was concerned.

The work was begun on Oct. 9, 1917, and the tunnel was finished March 11, 1918, a total of 154 days. The actual working time was 150 days, four days being lost on account of a break in the power line.

The length of the adit is 2,903 ft. and the daily average progress was 19.3 ft. for each working day. The greatest advance in any one month was in December, 1917, when a total of 645 ft. was driven. The amount of rock handled is estimated at 185 tons per day. The material penetrated was granodiorite, for the greater part of the distance. The total cost of driving the tunnel was $103,242, which brings the cost per foot of tunnel to $35.56. Certain equipment and supplies were charged against the work that should have been carried in a suspense account, as most of these had a certain salvage value because it was intended to use them in the future operation of the mines. For reasons already mentioned, such as expensive power, the cost given does not really represent the actual expense of driving. Had speed not been so important, no doubt the work could have been done more cheaply. A few of the cost items are as follows:

Total Driving Cost:	Total	Per ft.
Labor	[illegible]	[illegible]
Explosives	[illegible]	[illegible]
Drills, parts and repairs	[illegible]	[illegible]
Steel, sharpening and replacement	[illegible]	[illegible]
Miscellaneous supplies	[illegible]	[illegible]
Power	[illegible]	[illegible]
	[illegible]	[illegible]
Rock Disposal:		
Labor	[illegible]	[illegible]
Supplies	[illegible]	[illegible]
Power	[illegible]	0.29
	[illegible]	[illegible]
Timbering:		
Labor	[illegible]	[illegible]
Timber and supplies	[illegible]	[illegible]
	$3,848	$1.32
Tunnel Expense:		
Air and water lines	[illegible]	[illegible]
Electric lighting	[illegible]	[illegible]
Ventilation	[illegible]	[illegible]
Dump tracks and trestles	[illegible]	[illegible]
Depreciation on cable	[illegible]	[illegible]
Depreciation on cars	301	.11
Surface construction and machinery	[illegible]	[illegible]
Miscellaneous supplies	[illegible]	[illegible]
	$16,105	$5.55
Total cost	$103,242	$35.56

Timbering Details:

[illegible] sets timber installed, cost per set	[illegible]
354 ft. of tunnel timbered, cost per foot..........	10.83

Drilling Details:

Actual drilling time	[illegible]
Actual working days	[illegible]
Average drilling hours per day	[illegible]
Cost of upkeep per drilling hour, net	[illegible]

The credit of working out the plans and details of this work belongs to Mr. F. S. Norcross, Jr., at that time superintendent of mines of the Canada Copper Corp., now a captain in the 27th Regiment of Engineers, the mining regiment, at present in France. Captain Norcross was unable to complete the job, as he enlisted in December, 1917, but the work was carried out by his successor and former assistant engineer, Mr. F. E. Crane.

New Product for Disinfecting Small Quantities of Water

As the result of a study by Dr. Henry A. Dakin, the English chemist, a new product has been found for disinfecting such small quantities of water as used by the soldier or the engineer in their water bottles. The experiment conducted by Dr. Dakin indicates that the substance will sterilize an ordinary heavily contaminated water (e. g., containing coli, typhoid or cholera organisms) in about 30 minutes. It imparts a perceptible but not disagreeable taste to the water. The disinfectant is put up in the form of tablets, which if properly made are stated to be quite stable enough for all practical use. To ascertain the effectiveness of the tablets on a heavily polluted water, a series of tests was made recently in the water laboratory of the Bureau of Engineering of the Florida State Board of Health. The water used was obtained from a stream heavily polluted with surface wash and receiving considerable sewage. In the test one tablet was applied to each 250 cc. sample. The raw water contained 5,000 bacteria per cubic centimeter. After the tablet had been in the water 15 minutes the count was 500 bacteria per cubic centimeter; after 20 minutes, 160, and after 30 minutes, 50, which is a 99 per cent reduction in 30 minutes. A second series of samples from the same source was tested, a tablet and four drops of lemon juice being added to each 250 cc. of water. In this test the bacteria count was reduced to 120 in 15 minutes, to 90 in 20 minutes, and to 50 in 30 minutes. These results, states the official bulletin of the State Board of Health from which this note is taken, indicate mainly that the tablets effectively disinfect small quantities of heavily polluted water within 20 to 30 minutes with a complete disappearance of gas-forming organisims and colon forms as well as a great diminution of bacteria. The addition of lemon juice apparently hastens the effectiveness to a degree. The chemical name for this disinfecting agent is Parasulphondichloraminobenzoic acid. Its common name is halazone. Halazone tablets are prepared in a convenient form by several large laboratories, small vials of 100 to 1,000 being on the market.

30 Labor Saving Devices or "Kinks" for Railway Maintenance of Way Work

[illegible] Railway Labor submitted [illegible] the American Rail[illegible] the committee on Labor Saving [illegible] of kinks and special [illegible] in railway service.

Roadbed Cultivator.—This is an implement for economically [illegible] ballast which has settled or become [illegible], and reshaping of the [illegible]. The equipment is mounted upon [illegible] purpose and consists of a [illegible] ballast spreader located to [illegible].

[illegible] of the plows and scraper is done by air pressure and can be entirely controlled by two men.

[illegible] is placed forward and above the outer plow. The forward plow cuts a furrow in the road[illegible] the bottom of this furrow being slightly below the level of the bottoms of the ties. [illegible] is thus thrown [illegible] up onto the ends [illegible] that is adjacent to the [illegible] than that further down the [illegible] and it is the function of the forward [illegible] gravel from the upper part of the roadbed and pile it temporarily on the ends of the ties.

The plow following below and outside of the first plow throws the relatively coarse gravel of the lower portion of the slope of the roadbed up into the furrow made by the first plow, the bottom of which furrow, as before stated, is slightly below the level of the bottom of the ties. Thus free drainage is provided for that portion of the roadbed immediately below the ties.

The horizontal scraper following the plows is adjusted to [illegible] running parallel and adjacent to the rail. The inclined portion of the scraper scrapes the relatively fine gravel which has been thrown up onto the tie ends by the first plow off of the tie ends and over the edge of the roadbed, whereupon this gravel falls down into the lower furrow made by the second plow. Thus by the co-operative action of the two plows and the scraper, the relatively coarse gravel at the lower edge of the slope of the edge of the roadbed and the relatively fine gravel at the upper part thereof are made to change places. The scraper or spreader smooths out any inequality in the slope of the roadbed left by the plows and forms slope to the desired contour.

Inasmuch as similar members are mounted on both sides of the cars, out controlled by separate mechanisms, the two sides of the roadbed may or may not be treated simultaneously as convenience or necessity may direct. Means are provided to permit operation of the cultivator over irregularities in the roadbed, on curves, where the outside rail is raised and where obstructions are encountered. Not only can the plows and scrapers be raised up to a vertical position to clear [illegible] may also be swung back or in towards the side of the car.

The cost of operation of the roadbed cultivator per mile of track varies considerably according to obstructions encountered, as well as density of traffic, but considerable of the work has been done at a cost as low as $1.30 per mile. This cost includes engine service, wages of train and engine crew, as well as wages of operators on the cultivator.

Light Derrick.—A light derrick, handling 3,000-lb. loads, that can be quickly mounted on an ordinary push car, has been found to be a great labor saver in bridge gangs.

Tie Plate Elevator.—The tie plate elevator consists of a link belt conveyor upon which tie plates are received after leaving the punching machine. Through means of the link conveyor, plates are elevated to a sufficient height and discharged upon an inclined plane which is swung over the track in such manner as may be desired to discharge plates directly into gondola or other type of car spotted for loading. The machine is rendering very efficient service.

Oil Sprinkling Device.—This attachment consists of a perforated 2½-in. black iron pipe, coupled to the discharge openings of a standard oil tank car. Perforations in pipe consist of ½-in. hloes placed 2 in. center and threaded for plugs. Plugs are used in the alternate holes when the oil is hot and running freely. In cold weather plugs are removed in order to secure proper flow of oil. The swing joints in the pipe consist of ordinary elbows with a nipple between them.

Straddle Leg Pile Driver.—This device was used in work on the trestle across Great Salt Lake. The structure is 12 miles long, carrying very heavy traffic, and piles could not be driven with an ordinary car pile driver without great delay to trains and heavy expense for work trains. Floating pile drivers could not be employed on account of the rougness of the lake.

Accordingly an ordinary straddle leg bridge traveler was adapted to pile driving purposes. The driver moves on rollers on the outer edges of the deck, the engines being placed on the upper platform and leads are pivoted so as to swing in either direction. The trestle is of the ballasted deck type and is 16 ft. wide. The driver is 14 ft. 8 in. wide and 22 ft. high in the clear, making it possible for trains to operate through it without interfering with the driving.

Tie Plug Machine.—In years past it has been customary for section men to make tie plugs from straight grain redwood ties. Plugs were sawed 4 in. in length and split with a hatchet as near as possible to size. The average output per man per day was 1,000 plugs. Several types of machines were devised for sawing and sizing plugs. A machine was finally perfected with an output of 100,000 plugs per day at a cost of 55 ct. per thousand. Mr. Carman recently designed and has obtained U. S. Letters Patent No. 1,218,836, on an improved type of tie plug machine, which will have an avergae output of 400,000 tie plugs per day, at a cost ranging from 26 ct. to 40 ct. per thousand, according to the price of the lumber from which the plugs are manufactured.

Prior to the advent of the new machine, mill-sawed timber was used in the manufacture of the tie plugs, whereas the new machine will turn out the plugs from timber as it comes from the forest and will work up refuse lumber about the lumber mills.

It is preferable to locate the machine and manufacture the tie plugs at mills where the timber is handled.

Weed Burner.—The weed burner is constructed on a car 52 ft. in length, the body of which is made from scrap steel bridge girders. The car carries a burning table, lined with fire brick, with a movable wing on each side of the table to extend out over and down the shoulder of the bank for the purpose of directing the flames onto the outer slope of the bank. The burning table, as well as the wings, are raised and lowered by air pressure. Valves covering the operation of the burning table and wings are centrally located, making it possible for one man to readily control the burning operation.

Distillate is used for fuel and is sprayed with steam pressure supplied from the locomotive.

The implement was designed for the purpose of burning grass and weeds upon the track and the best results are obtained in the early spring while the grass is yet green, the object being to sear the growth and kill the root. As a general rule, two burnings are required for good results; the second burning following the first by an interval of a few days. Where the weed growth is very light or quite dry, one burning may be found sufficient. In order to keep the roadbed entirely free from weeds, some supplemental hand work usually has to be done where the growth is unusually heavy or where certain patches of perennial vegetation may occur; but, on the whole, it is considered an economical operation, as compared with depending upon hand labor, even in normal times, and all the more so under prevailing conditions.

The average cost, all items of expense included, for first burning has been approximately $10 per mile and for the second burning $6 per mile, or a total of $16 per mile where first and second burnings have been made.

Extension Beam.—This is a convenience for jacking up derailed locomotives. The device consists of four steel plates 6 ft. long with 3-in. holes placed every 12 in. to receive a pin of the same diameter, which engages the underside of the pilot beam and the top face of a 12x12x18-ft. timber which extends a sufficient distance outside of the track and affords a purchase high enough to secure adequate foundation for jacks without the usual excavation. In practice, the device has proven most successful and eliminates considerable lost time in re-railing of locomotives and consequent damage to track where practice of pulling them is applied.

Frog Wing Bender and Templet.—This tool consists of ordinary switch tie for a foundation, around which is fastened a "U' strap, which is drilled near the end of arms to receive a 2½-in. pin which engages the wing rail to be bent. An ordinary track jack is applied at one end after proper heating. Templet is made of gas pipe as an adjustable middle arm and when adjusted to the old wing will produce the same angle when placed in the same relative position on the rail to be shaped. In practice it has been found possible to heat and bend a rail to the desired angle in 10 minutes, which is about 10 per cent of the time ordinarily required where hammer and angle is used and a more satisfactory job is otained. The same tool is also used for making short breaks of rail in maintenance of way shop.

Power Rail Curver.—This device consists of old-style Elliott stationary roller bender anchored to a dead-man in a vertical position, the rail being passed to the rollers in the usual manner, the movable part tightened and power applied either by locomotive or stationary engine and rail drawn through, against the usual practice of a socket wrench and hand power. In this manner 125 rails per 10-hour day may be curved to the desired radius with eight men and an engineer. This machine is used to curve lead and curve rails and for straightening of damaged rails and curving of guard rails. Surface rails are also straightened by reversing the position of the rail in the roller.

Screw Spike Remover.—This device consists of attaching a large wheel to a screw spike wrench in place of the ordinary T-handle. It is noticeable that in removing screw spikes, two men are required and the constant changing of hands on the ordinary T-handle makes the process slow and awkward. If a large wheel, of the old heavy type of a brake wheel with a handle attached to its side, is used, the momentum of the wheel held by one man and revolved by the handle by the other without removing his hand, will quickly remove a spike from a tie.

Erection and Repairs of Water Columns or Removal.—This kink consists of a collapsible A-frame made of 2-in. and 2½-in. pipe and guyed two ways with a 1-in. rope, to carry the overhead blocking necessary to hoist the parts in place. Ordinarily a long wooden tripod is used for erecting any part of the crane and setting this up requires at least four men. The length of these legs is 22 ft. If the crane is in an isolated place and is an important water station, it is expedient that the new parts and the tools for replacing them be hurried along by passenger train. With two such collapsible legs made up of a 12-ft. length of 2½-in. pipe with 12-ft. extension of 2-in. pipe and enough tackle and rope to guy the frames both ways, two men can handle any part, and easily place it in the baggage car of the train.

Shackle Band for Repairing Timber Trestles.—This is a device used on timber trestles where caps are in need of renewing or the stringers need shimming on account of the settling of the bents. A shackle band is made of 1-in. x 4-in. iron bent so as to fit over an upright post of the bent itself. Another shackle band is made to fit inside the first and held there by a 1-in. bolt. The back of the smaller band is sharpened somewhat in forging, so that it will grip the 12-in. timber as soon as any weight is put on it.

The bolt is removed when the device is to be used, the larger band slipped around the 12-in. x 12-in. and the inner band put in place. It can be put around the bottom of a 12x12 post and two men can raise it to the required height. After the weight of the larger band is taken by the sharp edge of the smaller it grips the timber and the grip increases with the weight put on it. Two such bands will make a scaffold that will raise any set of stringers. If a joint comes over the bent, all that is necessary is to chain both sides of the rail and lift rail and all. Then the bent is free to take off the cap or even replace one of the posts if necessary.

Rail Unloader.—This consists of an apron and hook for unloading rail endwise from flat cars. A chain is used with hook on one end and a bolt that can be put through a hole in the rail at the other end.

The hook is set over the end of a splice in the track and as the car is moved slowly forward the rail is unloaded, and the sloping pieces of the apron guide the rail to the side of the track outside of the track rail.

Track Liner.—This device is a wedge-shaped wooden block, 18 in. long, 8 in. wide and 2 to 5 in. thick, cut out of a tie or piece of 5-in. crossing plank and put under the rail, the 8-in. x 18-in. base of the block being set horizontally. The claw bar is then put under the rail and by pressing down towards the ground on this claw bar it is said one can do as much lining with three men as can be done with six men prying up on lining bars. A 2-in. diameter pipe 5 ft. long is attached to the end of the claw bar to give the men leverage. The ballast is moved from the ends of the ties and dug out between ties about down to the bed or base of the ties, so that the block may be put in and so that the claw bar will fit snugly between the base of the rail and the block. The men then put the pipe on the claw bar and put it in place, prying down on the claw bar; this kicks the track over to line. It is particularly useful in cinder ballast. It is also said to be used to good advantage on slips, which in the winter time have to be lined very frequently. It is said that during last winter on a 5-mile section, containing about 1½ miles of slipping track, a foreman with only two men was able to keep this track in line. In soft weather, where this track had to be lined almost every other day, for from 2 to 4 in., the foreman did all of his lining with this block and claw bar.

Tie Plug Driving Device.—This device is similar to a concrete tamper, with a large, flat head, for driving tie plugs while in standing position, which makes the driving much easier and much quicker.

Rail Roller.—This is a simple roller device used for the driving rail where it is necessary to space rail or open up joints, and is a substitute for the ordinary method of lifting the bumping rail with tongs and sliding it over angle bars.

Machine for Replacing Bridge Ties.—This device consists of a horizontal 20-ft. wood boom set in a steel underframe on which is mounted a windlass operating grab hooks by means of a system of cables and pulleys, the whole machine resting across a push car above the ties to be replaced.

The base is an 8-in. channel iron 12 ft. long, on each end of which is erected a ¾-in. x 4-in. stirrup or U-shaped iron, riveted through the bottom of the channel. Between the uprights of this stirrup are two rollers 6 in. in diameter placed about 6 in. apart. Between these rollers is a wooden boom 5 in. x 6 in. x 19.6 ft., with a 4-in. sheave in each end, over which a ⅜-in. wire cable runs to two small flanged pulleys 4 in. in diameter with cranks attached. This is for hoisting or lowering the ties. The pulleys have notched edges on one side in which a dog engages to hold the tie at desired height. There is a pulley on the channel iron shown just at the edge of push car. This has ¼-in. wire cable two turns around and locking, and is used to extend to draw in the boom. There are grab hooks on end of cable for fastening to ties. The machine is also supplied with anchors from end of channel iron which hook nder guard rails. It is only necessary to use this when removing or replacing caps to keep machine from tipping over.

In replacing ties, the old tie coming out balances the new one being put in and anchors are not required. In replacing ties small quick-lifting jacks are used, set on the stringers between the ties and raise ties clear of the stringers about 2 in.

It is said that this avoids the necessity of removing guard rails, and that 80 ties have been placed with it by six men in one day. The push car is equipped with a plate fastened to deck of car, through which a king bolt is inserted, thus allowing it to be swung at an angle. It can be lifted off the car readily.

Painting of Signs with Raised Letters.—The practice which is here suggested and has been used with very good results, is to take a piece of plush drawn tightly over block of wood 2x3x¾ in. and tack the plush to the edges. Paint should be thick and applied to plush pad with a brush. The pad should then be rubbed over the face of the letters very lightly. This practice has been used for a number of years, and it is found that on signs with a great deal of lettering as much work can be done in 5 minutes with this device as with a paint brush in from 2 to 3 hours. Furthermore, the work has been found to be durable.

Staggered Switch Points.—Wear on switch points and the possibility of derailments where switches depart from the inside of curves has been a very serious matter. To overcome this, certain roads have staggered their switch points by placing the one switch point 2 ft. ahead of the other, in order to be able to place a guard rail opposite the switch point on the high side of the curve and thus relieve the wear and tear and strain against that point. This is particularly

[illegible]

Foot Rest for Shovel.—[illegible] The gas pipe, however, has the advantage [illegible] and is easier [illegible] give good [illegible]

Lining Bar Foot.—[illegible] When [illegible] and makes a [illegible] slipping and increasing the leverage of the bar. It is said that by the use of this device [illegible] speed than otherwise.

Cultivator Disc for Cutting Sod Lines.—A cultivator disc on [illegible] has been [illegible] faster than [illegible] which looks [illegible] distance from the [illegible]

Rail Loader.—This machine is used where a regular loading machine or derrick car is not available. It is said to be very effective in picking up and loading rail along the tracks. It consists of [illegible] 100 ft. long, on one end there is a grab hook made from the jaws of a rail tong. This hook is used to fasten to the piece of rail being raised [illegible]. On the other end is a clutch also made from a rail tong [illegible] at about a 45° angle. This clutch is arranged to [illegible] the rail in track behind the car being loaded. The cable operates through a 6-in. sheave wheel, which is attached to a post fastened to the side of the car. This post can be made from a piece of short mill rail.

The operation of this device is very easy and simple. It is necessary to have the rail marked to show the exact center before the grab hook is applied. The clutch which is fastened [illegible] behind the car is operated by one man, who holds it solid and tight while the car is moved ahead far enough to raise the piece of rail above the side, then two men can turn the rail around to allow it to drop into the car when [illegible] the clutch releases it. Then the clutch is moved ahead and anchored to the track again, as the car is moved to the next piece of rail to be picked up. Rail along the tracks can be loaded in this manner about as fast as it could be handled with a derrick car, and few if any more men are required to do the work.

Portable Power Track Drill.—The portable power track drill is one of the coming labor-saving devices. There is now such a machine on the market, consisting of a small gasoline engine, belt connected to a drill designed to be clamped to the rail. The engine and drill weigh 300 lb. Such a drill has a capacity of 240 holes per day, including necessary moves from rail to rail.

Improvements along the lines of conservation of weight, increase in portability and decrease in number of parts will undoubtedly develop a machine of decided value to the track maintainer. There seems no reason why the same machine cannot be fitted with a device to tighten the nuts on track bolts inserted in the newly drilled holes.

Organize Peninsula Branch of Engineering Institute of Canada.—Members of the Engineering Institute of Canada and other engineers resident in the Niagara District met in Niagara Falls, Ontario, on March 11, and formed a "Niagara Peninsula" branch of the Institute. The branch was started with an initial membership of nearly 30. The following officers were elected:

Chairman, A. C. D. Blanchard, Niagara Falls, Ont.; Vice-Chairman, W. P. Near, St. Catharines, Ont.; Secretary-Treasurer, R. P. Johnson, Niagara Falls, Ont.

Licenses No Longer Required for Purchase of Dynamite.—The war-time regulations requiring licenses for the purchase, possession, and use of explosives for reclaiming land, stump blasting, ditching and other agricultural purposes was revoked March 15, by the Interior Department. The only qualification is that this revocation does not allow enemy aliens or subjects of a country allied with an enemy of the United States to manufacture, purchase or sell, use or possess explosives at any time.

Railroad Yard Construction Near Chicago

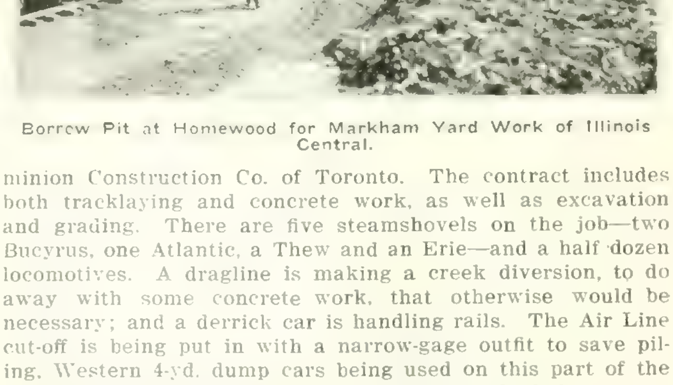
During these days of construction drouth preceding the hoped-for deluge of railroad work the Chicago terminal situation has resulted in several important railroad contracts. Work finally has begun on Chicago's new Union Passenger Station, to cost some $20,000,000 and to be occupied jointly by the Pennsylvania Lines, Chicago, Burlington & Quincy, Chicago, Milwaukee & St. Paul and Chicago & Alton Railroads. The Michigan Central R. R. is building great yards at Niles, Mich., for the handling and classification of freight to and from Chicago and the Illinois Central R. R. is building similar yards at Homewood, Ill., just south of Chicago.

Loading Narrow Gage Outfit on Air Line Cutoff of Michigan Central. Camp Cars Shown at Right.

The Michigan Central work, so far as contracts have been let, includes the construction of westbound yards and a 4-mile cut-off between these main-line yards and the Michigan Central Air Line, together with a 30-stall roundhouse, large machine shop, turntable, etc. Construction of eastbound yards is planned for next year.

The yards when completed will take the place of the present yards at Michigan City, Ind. The cut-off to the Air Line alone involves the handling of 625,000 cu. yd. of material, some heavy cuts averaging 24 ft. and filling from a pile trestle across nearly a mile of low ground. As the cuts will not furnish enough material for the filling, a borrow pit will be maintained by widening certain cuts as far as necessary. This is easily accomplished as the Michigan Central owns all the land in the vicinity.

The entire work except buildings has been let to the Dominion Construction Co. of Toronto. The contract includes both tracklaying and concrete work, as well as excavation and grading. There are five steamshovels on the job—two Bucyrus, one Atlantic, a Thew and an Erie—and a half dozen locomotives. A dragline is making a creek diversion, to do away with some concrete work, that otherwise would be necessary; and a derrick car is handling rails. The Air Line cut-off is being put in with a narrow-gage outfit to save piling. Western 4-yd. dump cars being used on this part of the work. A standard gage outfit, with Western 12-yd. dump cars, is being used on the main line and yard work.



Borrow Pit at Homewood for Markham Yard Work of Illinois Central.

The similar yards which are being built south of Chicago by the Illinois Central R. R. are known as the Markham Yards. They extend between Homewood and Harvey, 3 miles from lead to lead. At present the northbound yards only are being built and these have been nearly completed. The Walsh Construction Co. of Davenport, Ia., has the general contract. All material for the extensive fill must be borrowed. This fill averages from 5 to 8 ft. in depth except at the "hump," where a 30-ft. fill was necessary, made from a temporary trestle.

The Walsh Construction Co. and the Woolsey Construction Co. each have a standard gage outfit on this work, including Bucyrus shovels and 60 Western 12 and 16-yd. dump cars. This job of placing 1,500,000 cu. yd. of material began last August and will have been completed by early summer. The sandy material is ideal for handling, but the water is so hard that it has been found necesary to soften it by chemical treatment and filtration.

Motor Trucks and Short Line Railroads

In an address on the railroad situation delivered recently before the New York Railway Club, Mr. C. A. Morse, assistant director of the division of operation of the U. S. Railroad Administration, pointed out that the motor truck and automobile had introduced a new element into the transportation problem that should be taken into consideration at this time while studying the reorganization of the whole transportation question. He said: "Good roads are demanded for the use of the automobile, and a study should be made to see what additional expense would be necessary to construct them so that they would serve for the motor truck and tractor. Where heretofore development of the country for 50 miles on either side of a trunk line of railroad has required the construction of light branch lines, it is a question to be seriously considered whether this policy should be continued or whether good wagon roads should be constructed and the products of the farms and passenger travel should not be handled by motor truck and automobiles to the main line.

"Taken alone and considered as a unit, practically none of these small branch lines pay expenses, but as gatherers of freight and passengers to increase density of traffic on the trunk lines they are sources of profit. As, however, the traffic gathered by them is turned over to the main line with a deficit attached, which has to be overcome during main-line movement, before any profit is made, it would be a decided advantage if this traffic could be delivered to the trunk line by means of the motor truck, tractor and automobile, without this bill of expense attached.

"If the good roads had to be constructed and operated for the freight alone, it is a question whether they could be built and operated as cheaply as the light branch railroad, but when we find that the good road is demanded for the use of the automobile, and if it is found that the increase in cost to make it heavy enough for the truck is not too great, and if we take into consideration the fact that the farmer and merchant must deliver their products on good roads to the branch line by truck, thus doing the same handling as if they delivered them to the main line, it looks as if there was a possibility that delivery to the main line, and avoidance to the construction of the branch line, would be economical.

"Investigation of this subject may show the desirability, as good roads are completed, of the taking up of many branch line railroads and utilizing the abandoned roadbed for improved motor road, thus decreasing the expense of maintenance and operation of our railroads and giving in their places well located motor roads. Such a change would call for increased facilities at stations along the main line for passengers and for handling freight, including storage, trackage, etc."

English Channel Tunnel Would Cost $100,000,000—An English press report states that it is now estimated that five years would be required to complete the proposed tunnel under the English Channel from England to France. It is said that in ordinary times the cost of the work would be about $80,000,000, but in view of the increased cost of labor and materials, the expense involved would, under present conditions be nearly $100,000,000.

Lubrication of Air Compressors

Useful information on the qualities and quantities of oils required for satisfactory lubrication of air compressor cylinders is given in a report issued early this month by the Compressed Air Society. The report, extracts from which follow, was prepared by Mr. F. V. Conrad, secretary of the society, and is based on a careful study made by the technical committee of the society.

Heat of Air Compression.—The selection of an air cylinder lubricant is, of course, governed to a considerable extent by a knowledge of cylinder temperature it must withstand. Knowing the air pressures, the corresponding temperatures are ascertained fairly accurately, as shown in Table No. 1.

This table gives the final temperature in the cylinder at the end of the compression stroke, for single stage, also for two stage (or compound) compression, when the free air entering the cylinder is 60° F.

Variations from these temperatures will occur in actual practice due to water jacketed air cylinders and radiation, tending to lower the temperature at the higher pressures. But at, say, 50 lb. pressure and lower, the heat is likely to be somewhat greater than given by the table, particularly if the compressor is run at high speed and also if it is not water jacketed.

Relation of Oil Flash Point to Cylinder Temperature.—The natural inference of the reader after noting the temperatures in Table I, is that he must select an air cylinder oil whose flash point is higher than the maximum temperature apt to be encountered within the air cylinder. As a matter of fact, this is not the case, and it need only be carefully noted that: the study of the air cylinder temperatures is useful mainly in testing lubricating oils to determine their resistance against breaking down into carbon, etc. But such temperatures cannot be taken as limits establishing the highest allowable flash point for a lubricant safe to use in the air cylinders.

Qualities of Cylinder Lubricating Oils.—For average normal conditions, the oil should be a medium bodied pure mineral oil of the highest quality, not compounded with fixed oils such as animal or vegetable, and should be carefully filtered in the final process of manufacture.

Quite a range of oil composition is permissible for lubricants approved for this work, which are manufactured under the above conditions. Primarily a distinction must be made between those oils having a paraffin base as distinguished from those having an asphaltic base.

From a strictly operating standpoint—so it is claimed by some lubricant manufacturers—there is no distinction between these two classes of lubricants as to their desirability as compressor cylinders oils, provided that both have been properly filtered in the process of manufacture to remove the carbon-forming elements. If any carbon should be formed, however, such carbon deposited by the asphaltic base oils is of a light fluffy nature and easily cleaned out, whereas, that deposited by the paraffin base oil is very adhesive, and characterized by the hard, flinty nature.

Paraffin Base Lubricating Oils.—Merely as a guide to aid

TABLE I. CYLINDER TEMPERATURES AT END OF PISTON STROKE

Air pressure in Lbs. gage	Final temperature Single stage Degrees F	Final temperature Two stage Degrees F
10	[illegible]	
20	[illegible]	
30	[illegible]	
40	302	
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
130	550	265
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

TABLE II. PHYSICAL TESTS OF PARAFFIN BASE OILS

	Minimum	Average	Maximum
[illegible]	[illegible]	[illegible]	[illegible]
[illegible] (open cup)			
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
Congealing point			
[illegible]	[illegible]	[illegible]	[illegible]

[illegible] by an air cylinder lubricant recommended for average duty, Table I is given

[illegible] expressed [illegible] of low pressure [illegible] by maximum figures [illegible]

[illegible] lubricant intended [illegible] should meet the [illegible] of figures given in the middle column of the above table. The above wording, "standard air compressors," is to be interpreted as including the following types of machines.

[illegible] which may be either small sized single stage units, or larger sized compound machines.

[illegible] are constructed with the proper number of stages so that no excessive temperatures are ever reached.

In other words, this lubricant of average test figures is always recommended unless a compressor manufacturer specifies in his literature that a high flash point oil should be used to meet the conditions peculiar to his machine. It is thus obvious that it is never necessary that a lubricant should [illegible] unless abnormal conditions of high temperature prevail. Such high flash point oils have an unusual tendency to produce carbon deposits.

Asp[illegible] Base Lubricating Oils.—As a guide for the selection of suitable oil, the following table is given:

TABLE III—PHYSICAL [illegible] OF ASPHALTIC BASE OILS

	[illegible]	A[illegible]	Maximum.
[illegible]	[illegible]	[illegible]	19.5-20.5
[illegible]	[illegible]	315-335° F.	330-375° F.
[illegible]	[illegible]	370-400° F.	385-440° F.
[illegible]	[illegible]	275-325 sec.	[illegible]
[illegible]	[illegible]	Pale yellow	Pale yellow
[illegible]	[illegible] F.	—0° F.	—0° F.

For general all around use the recommendations given in Tables Nos. II and III cover the situation as well as possible, special cases, of course, requiring investigation and special consideration before making recommendations.

Proper Quantity of Lubricating Oils.—The quantity of lubricating oil to feed to the air cylinders of compressors cannot be stated in exact terms due to the varying viscosity of different oils, the heat of compression and the size of cylinder. It may be stated in general, however, that after cylinders have acquired smooth and polished surfaces, the quantity should be reduced to the lowest limit to avoid the possibility of the accumulation of carbon and sooty deposits within the system due to excessive use.

The following basis of quantity given in Table IV is recommended, subject to above modifications for these cylinders or equivalent sizes, operating under normal conditions.

TABLE IV—QUANTITY OF AIR CYLINDER LUBRICANT REQUIRED PER 10 HOUR DAY

Diameter of cylinder	Size of cylinder	[illegible]	[illegible]	[illegible]	Drops oil per minute	Drops oil per 10 hours	Sq. ft. oiled per drop	Number of pints oil required per 10 hours
[illegible]	[illegible]	120	[illegible]	718	1	600	718	.0375
[illegible]	[illegible]	320	[illegible]	1,230	2	1,200	613	.0750
[illegible]	[illegible]	880	496	2,340	[illegible]	2,400	585	.1506
[illegible]	[illegible]	1,730	[illegible]	[illegible]	[illegible]	3,600	[illegible]	.2250
[illegible]	[illegible]	2,940	[illegible]	4,700	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	4,550	644	[illegible]	10	6,000	607	.3750
[illegible]	[illegible]	6,700	[illegible]	7,600	12	[illegible]	633	[illegible]

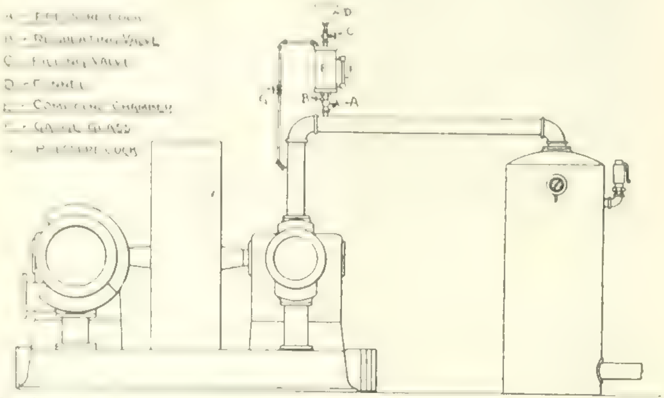
*Figures of last column are based upon an estimated 16,000 drops [illegible]

It will, of course, be carefully noted and clearly understood that the results in the last column of Table IV are based upon the assumption that under average conditions of temperature and usual range of oil viscosities, a pint of oil will contain an average of about 16,000 drops. It is, of course, understood that these figures are offered merely as an approximate guide and that every individual must exercise his own judgment in modifying them wherever his own particular set of working conditions is unusual.

A leading authority on compressor engineering contributes the following: "The best way to determine the proper amount of lubrication is to take out the valves from time to time and examine the cylinder. All parts should feel that there is oil thereon. If they feel dry, the lubricators should be adjusted to feed a little more oil, whereas if oil lies in the cylinder and its parts show excessive oil thereon, the quantity fed by the lubricators should be reduced. By thus examining the machine a few times, the proper amount of oil can be determined to suit the characteristics of the particular lubricant used and the conditions under which the machine operates." This is a better way to finally determine the quantity of oil required than by adopting without this experimenting any tabulated number of drops.

Periodical Cleansing of System.—The best of lubricating oils will cause the deposit of enough carbon in the compressor system to necessitate the periodical cleansing of it.

For the removal of carbon the machine operator should confine his efforts to the use of soap suds. A good cleansing solution is made of 1 part soft soap to 15 parts water. These suds should take the place of oil for a few hours, and be fed into the air cylinders about once a week, either by means of a hand pump or through the regular lubricator at a rate of about ten times as rapidly as that of the oil. The cleanliness of the air valves when inspected, as they should be periodically, will indicate whether greater or lesser applications of the soap suds should be made. After using soap suds, open the drain cock of the air receiver, and of the inter-cooler in the case of compound machines, to draw off any accumulated liquid. Oil should be used again for a half hour before shutting down the machine in order to prevent rusting the cylinder and its fittings. Never use kerosene, gasoline or lighter oils in an air cylinder for any purpose whatever, because of their volatile nature under heated conditions.



Device for Cleaning Carbon in Air Discharge Line and Receiver of Air Compressors.

To use compound: Close cock "A" and "G," open valve "C" and fill compound through funnel "D," when chamber "E" is filled close valve "C," open cock "G" and "A" and regulate feed by valve "B", use about 70 drops per minute.

Cleaning Air Receiver and Piping.—It often happens that oil, carbon and other foreign matters are deposited in the air discharge lines and air receiver. A practical method of cleaning these is shown in illustration, where a receptacle made of 6-in. pipe is shown set on top of the discharge pipe. The cut shows plainly the construction and what the different parts represent. If a mixture of 1 lb. of Red Seal lye and 18 lb. of water is passed into the discharge line at the rate of 60 or 70 drops per minute, while the compressor is running, this will eat out all the accumulation on the surface of the pipe and in the receiver, and if the blow-off valve on receiver is open, all of this foreign matter will be discharged therefrom. This cleaning solution can be used every month or two, depending on how much accumulation there may be in the receiver.

Steam Cylinder Lubrication.—The proper quantity of oil to be fed to steam cylinder is much greater than to air cylinders, due to the constant washing away of the oil by the steam. Approximately four times as much oil will be needed in the steam cylinders as in those for air, subject, of course, to variable local conditions.

Depending on its viscosity, a pint of steam cylinder oil will furnish from 5,000 to 8,000 drops, and taking an average

TABLE V—QUANTITY OF OIL FOR STEAM CYLINDER LUBRICATION.

No. drops per minute	Size of cylinder, inches.	Number pints oil required per 10 hours.
[illegible]	8x 8	.4
[illegible]	12x12	.75
[illegible]	18x18	1.5
24	24x24	2.25
32	30x30	3.0
[illegible]	36x36	3.75
[illegible]	42x42	4.5

of about 6,500 drops, and four times as much oil as air cylinders of same size, and working at same piston speeds, as given in Table IV, the recommended amounts to feed the steam cylinders or their equivalents are given in Table V.

These figures are approximate only, and will vary with the steam conditions, the kind of oil used, and its method of introduction into the steam, also with the boiler compound carried by the steam in the cylinder.

Observations on Changing Tested Oils.—When the operator of an air compressor succeeds in obtaining lubricating oils that are giving satisfactory results, he should be very cautious about making a change to other grades, particularly if cheapening the cost is advocated by purchasing and sales agents. But if a change is decided on, the performance of the new lubricants should be most carefully checked up before damage can occur to the rubbing surfaces of the compressor, and to see that no increased amount of deposit collect on the inside walls of the air receiver.

The most satisfactory way to get the quickest results is to put up the problem of lubricants to the local experts of any reputable lubricating companies, and to be governed by their recommendations, which, however, should be based on the foregoing statement.

Compressed Air Plant for Contracting*

By W. L. SAUNDERS.

The increasing importance of compressed air plant equipment in contracting has been the natural outgrowth of the contractors' development of methods, which demanded the introduction of tools of great ruggedness and high capacity. The success of certain characters of work, as for instance, pneumatic caisson foundation sinking, the shield method of driving subaqueous tunnels, are entirely dependent upon compressed air. It may, therefore, be safely said that compressed air plant forms an essential part of the contractor's equipment, and the problem resolves itself entirely into one of the selection of that compressed air plant which will best meet his needs.

Type of Compressor.—The character of the work is an important feature in the determining of the size and the selecting of the type of air compressor plant; for instance, such work as tunnel driving, aqueduct construction, canal excavation, etc., might well utilize a number of semi-permanent air compressor installations, as such work usually extends over a considerable period of time. On the other hand, such work as road building, open cut excavation, trench digging, structural work, etc., could more profitably employ portable air compressor plants which move with the work.

In the case of semi-permanent installations the requirements may call for the installation of both high pressure and low pressure units, the former for purposes of operating rock excavating machinery, pneumatic placing of concrete, the operation of water pumps, hoisting engines, pneumatic riveters, and the like.

The availability of motive power will be a deciding feature in the selection of the type of air compressor.

Air or Steam Plant?—In earlier practice it was customary to operate rock excavating machinery by steam, utilizing the boiler horse power direct, and thereby eliminating one item in the initial cost of equipment. On the other hand, the development of efficient steam operated air compressors and greatly improved compressed air operated rock drills caused the contractor to realize that he could effect more efficient and economical operation by installing an air compressor, than he could by adhering to the now admittedly obsolete practice. The greater loss experienced in the transmission of steam over long distances, as compared with that of air, and the greater consumption of boiler horse power in the rock excavating machine per unit of work, as compared with compressed air drills, more than compensated for the additional initial outlay.

Operating Power.—In some isolated cases where hydro-electric power could be generated on the job, the question of choice of compressor motive power is a simple one. A notable instance of such practice is that of the Laramie Pondre irrigation tunnel driven in Colorado, where Pelton water wheels were installed for driving generator sets, supplying current to short belt motor driven air compressors.

For portable compressed air plants, the choice of motive power falls naturally to gasoline driven types, due to comparative lightness of the equipment, the simplicity of operation and the ease with which satisfactory operating labor may be secured. On city street work it is sometimes advisable to use a motor driven portable unit, securing electric power from trolley lines or commercial power circuits. In building construction the semi-portable skid-mounted motor driven units are customarily employed.

Selection of Compressor.—In the selection of the air compressor, the contractor should give attention to the question of permanence of the equipment or its possible salvage value as in the case of a large project involving the installation of an elaborate plant, upon its completion he may have no further opportunity to utilize a plant of such large capacity, and therefore becomes necessary to salvage it. On the other hand, a portable unit invariably becomes a permanent part of his equipment. This presupposes that a high-grade plant will be in better condition upon completion of a job, and therefore return a greater salvage value.

The volume of the work to be performed will determine the number of tools it is necessary to use, and this in turn will determine the size of air compressor to purchase.

Air Consumption.—Manufacturers of rock drills and other pneumatic appliances for contracting, publish figures of air consumption at various pressures, and it is, therefore, comparatively simple to determine the amount of air required to operate a given number of tools. To this should be added a margin of safety, as invariably the contractor finds many other adaptations for the air. This margin of safety will vary from 10 to 20 per cent, depending upon the magnitude of the undertaking.

Installation.—With semi-permanent installations it becomes necessary to provide suitable housing and foundations of semi-permanent character. The question of housing is a simple one, the only precaution required is the protection of the plant from the elements. With work of long duration, it is advisable to install a foundation of mass concrete or stone masonry structure. This is particularly true of large machines. Machines of small and moderate capacity customarily employed on short time jobs give satisfactory service bolted to skid foundations, firmly anchored.

On penalty jobs, or in such work as pneumatic caisson sinking or shield tunneling, where the lives of the workmen are dependent on the absolute uninterruption of the air supply, it is imperative to install duplicate units, so as to insure against failure of the power supplied.

The radius of distribution of compressed air from a central station is practically without limit.

Equating Cost.—The determining factor is the balancing of the comparative cost of the installation of one large plant and the cost of transmission line necessarily large in diameter, plus operating cost, with the installation of smaller units with smaller transmission lines, plus operating cost. In the transmision of air over long distances, the cost of the air line installation may reach a point where it will more than pay for the installation of a number of small units and give more satisfactory service.

Transmission.—Transmission lines will vary from 2 to 6 in. in diameter, depending upon the size of the installation and the distance of transmission. Suitable control valves should be provided at the power house, as well as the points of outlet.

In pneumatic caisson work an after-cooler forms an essential part of the air compressor equipment, it being utilized to remove the heat of compression and deliver the air to the air locks at normal temperature.

In the operation of pneumatic tools of various kinds, particularly in cold weather, some trouble may be experienced from freezing, and under such circumstances it becomes advisable to install some form of air reheater, which not only eliminates this trouble but increases the power delivered by the air compressing plant.

A properly designed air transmission line should include the installation of moisture traps at convenient intervals for the removal of the moisture, which the air contains and which is deposited in the transmission line.

Maintenance.—Modern air compressors have reached such a high state of refinement that aside from an occasional inspection to insure tightness of stuffing boxes, absence of leakage in the transmission line, and the proper functioning of the lubricating devices require very little attention on

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*From Compressed Air Magazine.

[illegible]

Concreting 2,000 Ft. Single Track Railway Tunnel in Service

[illegible] steel forms [illegible] tunnel on the Pitts- [illegible] in 1911

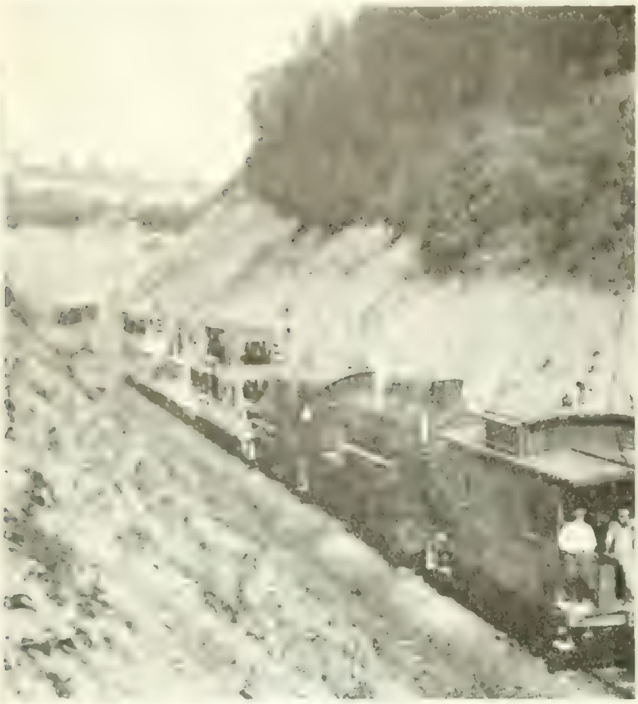


Fig. 1—[illegible] Sheeting and Waterproofing.

[illegible] It extends through coal, [illegible] as a consequence was heavily timbered [illegible] vertical posts and 5 segment arches with 3 ft. centers and sheeted with 3-in. planks. The cross section was approximately horseshoe shaped, and about 20½ ft. wide by 26 ft. high. The concreted portal was 16½

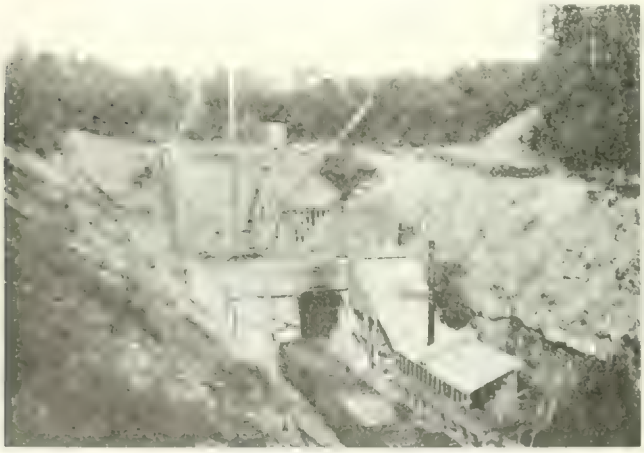


Fig. 2—Mixing Plant and Aggregate Bins at Tunnel Portal.

ft. wide by 24 ft. high. The usual daily traffic through the tunnel consists of about ten long coal trains, each pulled by three locomotives and several passenger trains. Serious decay of the timbers had taken place and in order to reinforce them and safeguard the tunnel a concrete lining was con- [illegible] the inner faces of the timbers were sheeted with ⅞-in. tongue and groove boards covered on the inside with 3-ply paper and waterproofing. The space between the bents and the old and new sheetings was filled with gravel to permit free drainage of water. The inner sheeting and waterproofing were placed from 12 ft. tower mounted on the platform of a flat car. The arrangement is shown in Fig. 1. The working platforms were carried on beams and could be pulled in to permit the car to enter the narrow portal.

Sand and gravel bins with a combined capacity of 80 cu. yd. were erected on the tunnel portal and the mixing plant was placed at track level. The cement was stored in a shed about 1 mile from the portal and was brought to the work on flat cars. A 300-ft. special siding was built adjacent to the main track at the tunnel entrance for delivery of the cars of sand, gravel and cement. The sand and gravel were placed in the bins by a derrick and clam shell and were delivered to the mixer by gravity.

Four Blaw collapsible steel forms in 30-ft. sections were used in the concreting. The forms were mounted on towers traveling on special broad gauge tracks, which permitted the train service to pass through them without interruption. The forms were faced with steel plates up to the springing line, above that point detachable wooden lining was employed.

The concrete was mixed in a Ransome-Caniff pneumatic mixer and was delivered through a 6-in. steel pipe with one 22 bend. The pipe terminated in a 30-ft. long rubber hose through which the concrete was discharged into the 2-ft. space between the form and the old lining. The concreting was carried toward the mixing plant. At the beginning of the work the delivery pipe was laid the full 2,000 ft. length of the tunnel. At each form it was disconnected, the rubber hose attached, and a section of lining concreted. The hose was then disconnected and moved back to the next form and reconnected.

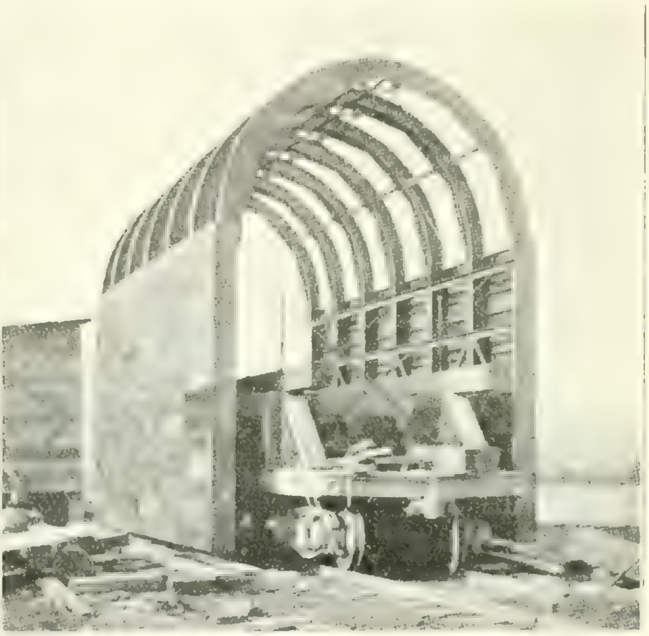


Fig. 3—Steel Form Carried on Platform Car.

The gang at the mixer consisted of five men, which included one man at the aggregate bins. In addition, a variable number of men were employed in stripping and cleaning the forms, extending the pipes, etc. Two 10-hour shifts were worked per day, and concreting was advanced at the rate of about 120 ft. per week. The forms were left in place until the concrete was at least 48 hours old. The forms left a smooth surface that required no further treatment.

The work was carried on in cold weather, and to protect the men in the tunnel from the draft that swept through it, both portals were closed by heavy tarpaulin curtains. On the approach of a train these curtains were rolled up to clear the wing walls and rolled transversely back to free the entrance for the passage of the train. Steam coils were provided in the storage bins to prevent the freezing of aggregate in cold weather.

The contractors were the Westinghouse, Church, Kerr & Co., Inc., A. J. Murphy being the superintendent.

Method of Lining Shafts With Concrete

In lining with concrete two shafts at the Tener mine, Chisholm, Minn., two methods were employed in sending down the concrete from the shaft collars. At one shaft the mixture was dropped 300 feet through a 4-in. pipe; at the other shaft a specially made car was filled with the concrete and lowered on the cage. An interesting description of the two methods is given in the Engineering and Mining Journal by Mr. G. G. Stonemark, mining engineer of the Oliver Iron Mining Co. The matter following is extracted from Mr. Stonemark's article:

The following methods were used in lining with concrete the Tener shafts "A" and "C" of the Oliver Iron Mining Co., at Chisholm, Minn. The head-frame at "C" shaft, Tener mine, is higher than usual above the collar, and higher also than is general practice on the Mesabi range, and has an ore pocket of ample dimensions. Inside of the pocket was built a temporary partition, dividing it so that sand could be placed in one-third of the space and the remainder allowed for rock. The cement was stored in a temporary shed constructed in the framework beneath the pocket, but was placed at an elevation over the mixer. The loading track was next moved as near as possible to the headframe, an opening between the rails excavated, and a launder used as a chute was built to extend down to the nearest compartment of the shaft. This compartment was bulkheaded and boarded up to form a skip pit, having an opening over the wall plate and with the end of the launder chute extending through.

All the aggregate was loaded in ore cars, so that it was an easy matter to dump the contents into the launder, from which it could be drawn off into the skip and hoisted in the same manner as ore. A temporary hoist was installed for this purpose, because the other hoisting engine consisted of a single drum and was used to hoist the cage in the other compartments. If sand was to be hoisted, it would be dumped directly from the skip into the pocket. An inclined chute, built on an ordinary stock pile trestle car truck and wide enough to accommodate the full width of the skip, was used when rock was hoisted, and a skip loaded with rock dumped on this chute would simply slide across the sand compartment and into the rock compartment.

The quarter pans in the pockets were taken out, the chute was reversed, and a temporary covered chute built to hold the different aggregates which led down to the measuring hopper. This hopper was situated over the mixer and on the same level as the shed for the storage of cement. Each chute was provided with a quarter pan, so that the workmen could run out the required amount of the different aggregates. Two workmen were stationed here to fill the measuring hopper and another workman whose function it was to open the cement sacks, pour them into the measuring hopper, trip the outlet and chute it down to the mixer. Two men were stationed on the mixer floor to look after the water and dump the mixer into a specially made car, which was placed on the cage and lowered to the forms below. When the pouring was completed, the car was taken off and the cage used to hoist all material taken out of the shaft, such as old timbers and lagging, and also for lowering and hoisting the men.

No Time Gained in Sending Concrete Through a Pipe for Short Distances.—Before the work was started it was thought that the method of dropping the concrete through a pipe would be speedier. If the depth had been greater, this might have been so, but not in this instance, because, comparing the working time with that consumed at "A" shaft, in which all concrete was dropped through a pipe for a depth of 250 to 350 ft., the time taken to lower 45 to 50 batches at "C" averaged 3½ to 4 hours, the same as at "A." On timing several batches sent down 250 ft., it took on an average of 2½ to 3 minutes, with less time for shorter distances.

Elbow Used to Stop Force of Concrete Dropped Through a Pipe.—Comparing the two methods of conveying the concrete from the collar to the forms below, certain conditions will have to be met successfully, such as stopping the concrete when it is dropped through the pipe. At "A" shaft, where as the concrete was dropped through a 4-in. pipe, a hopper built at the top of the pipe at the collar conveyed the concrete to the pipe from the surface car. At the bottom of the pipe, in order to convey the concrete to the car on the cage, and regulate the flow, a long-sweep elbow was screwed to the column pipe. This elbow reduced the force of the rush of concrete to a medium flow, but so quickly did the concrete wear a hole through the elbow that it had to, be replaced at every pouring, and finally an extra heavy cast-steel elbow, with a short piece of pipe screwed on, was tried, with better success.

In depositing the concrete in the forms, essentially the same methods were used in both shafts. The door at the bottom of the hopper-shaped car on the cage was opened, and the concrete flowed through a hole in the cage floor into a section of a funnel-shaped pipe. This pipe had an opening about 18 in. in diameter at the top, tapered with a slight curve, and was reduced in section to about 8 in. at the other end, so as to fit a light steel pipe having lengths of 1, 2 and 4 ft., and so made as to telescope into each other by means of a pair of eyes riveted at one end and a pair of hooks at the other. This arrangement made a flexible pipe that would reach any part of the forms, and in almost any position desired for depositing concrete.

Among the difficulties encountered in dropping concrete through a pipe is the liability to clog, for care is not always taken to see that all large stones are removed. Several times during the pouring in "A" shaft, the column pipes had to be disconnected to determine where the clog was situated, and it was necessary to hammer the pipe until the concrete was loosened, in which case all the material remaining in the pipe was wasted.

Six Men Per Shift Lower and Distribute Concrete.—At "C" shaft all the concrete was lowered with the cage, using the same car as employed at "A," down to a sill placed across the shaft on the wall plates for each consecutive pouring. The same flexible pipe was used to distribute the concrete to any part of the forms. A shaftman, stationed on a platform built level with the sills, opened the door of the hopper-shaped car as soon as the cage came to rest on the sills, and it was a matter of a few seconds for the contents of the car to flow out. The cage was then hoisted to the surface, where another batch was in the mixer and ready to be dumped into the car. The process continued until a form was completely poured. The men knew their respective duties, and became more proficient as the work continued, so that extra help was not necessary. Of the six men employed, including the foreman for each shift, three were generally required in the shaft and the other three at the surface, although an additional man was always at the shaft to look after the odds and ends and to run the mixer when concreting was being done.

Manner of Placing First Form at Shaft Bottom.—If the lining is to start at the bottom of the shaft and the lines, surface plant, and all else is in readiness, the shaftmen first clean the bottom of the shaft of all dirt and remove all the old lining sets for 10 ft. or more, depending on conditions. If the bottom is in rock, no bearers will be required, but if not, hitches must be cut in the sides of the shaft to permit the placing of steel bearers, the length of which depends on the size of the shaft. These hitches should be at least from 1 to 1½ ft. deeper than the bottom of the shaft, so that a spread footing can be secured. In order to get the full benefit of the steel used for the bearers, concrete is slushed in and reinforced with short steel rails or other rods that can always be found in the scrap pile, and placed so as to form a grillage which is built to the level required for the bearers. The first form in the shaft is built as high as the top of the bearers. This is made of plank, set carefully to line and leveled up and the botton of the form made to fit the profile of the shaft bottom so that the concrete will not flow out. After the form is poured, it is allowed to stand for a few days, and during this time the sides of the shaft are trimmed out to the next line required for the thickness of the lining.

Wooden Forms Superseded by Steel.—Until the regular forms arrived, a few sets were placed by means of wooden forms in "C" shaft, but these were found to be uneconomical. The steel forms used by the Oliver Mining Co. were panel sections of such dimensions as to be easily handled by rope and block, and made of 3/16-in. plate stiffened at the edges by 2½-in. x 2½-in. x 3/16-in. angles. The panels varied in size, the smallest being 6½ in. x 12 in. and the largest 2 ft. 11 in. x 5 ft. 11½ in. In all, 46 panels were required for one complete 6-ft. set, and 32 for a 4-ft. set. In forming an end lining, six panels, and for a wall plate lining, eight panels, [illegible] pieces with nine small filling panels in between the end pieces and dividers. In removing the panels [illegible] keys of ½ in. x 4 in. [illegible] of the required length [illegible] had not been so placed it would have been [illegible] to remove the panels [illegible] and this gave the panel an additional space, so that all panels could readily be removed, and [illegible] panel was removed in a tier, the others were simply unbolted in consecutive order.

Reinforced Concrete Dividers and End Pieces Secure Shaft Rigidity.—To give the shaft lining a greater stability and a means to which the [illegible] could be fastened, cast concrete dividers and end pieces, reinforced by steel rods and of sufficient length to be well imbedded in the lining, were placed at intervals and the reinforcement was allowed to extend beyond the end. These end pieces and dividers also supported the steel forms in rigid alignment by means of cord holes so spaced that a bolt of short steel rod could be [illegible] through the [illegible] of the forms and into the end pieces or dividers. A set of end pieces and dividers was first placed on the bearers previously set and leveled up, and the first set of forms placed and bolted together, the slab reinforcement having been previously fabricated by wiring together vertical and horizontal reinforcing rods.

Inside the shaft forms, braces made of 2 or 2½-in. pipe were [illegible]. These braces were flattened and had holes made in each end, so that when they were fastened at an angle the correct dimensions necessary to hold the forms rigid could be secured. The braces were also used to support staging planks. Another set of spacers was required to keep the end pieces and dividers in alignment, and [illegible] plank, armored at each end with strap steel securely fastened and of such length as required between the end pieces and dividers. The forms were then shifted to conform with the plumb lines, and temporarily wedged to keep them in place during the pouring of the concrete. The reinforcing was held in place by a steel template fastened to the top of the forms. The lower end of the forms was tied to the rods of the preceding sets, which were cut long enough to extend 3 or 4 in. out of the [illegible]

Everything being ready for the pouring of the concrete, temporary sills were laid across the shaft on a wall plate [illegible] funnel-shaped spout having an 18-in. opening and slightly curved and reduced at the other end of telescope into the short section of the [illegible] previously described. A number of shaftmen were then sent to surface to handle the mixing, and other work. The hopper-shaped car was placed on the cage, the first batch of concrete started in the mixer, and when the desired consistence of the concrete was obtained it was sent on its way to form an integral part of a lasting structural unit. Immediately after the forms were placed, the concrete was covered with planks, and the work of removing the old timber and trimming for another set of forms was begun. Removing the old timber was dangerous, and care and watchfulness were absolutely essential, for paint rock and the other materials which have little or no support are generally loose, and it seemed at times that little [illegible] to bring down a mass of the ground.

Void Behind Shaft Lining Filled With Excavated Material.—All unnecessary material was hoisted to the surface in a bucket hung underneath the cage. In case too great a space between the form and the wall was left, a back form was built, and the space filled with the excavated material. When the sides were trimmed to the required dimensions, the work for the next form was placed and lined up the same as the preceding one.

Six complete sets of forms were used in both shafts, making a section of 24 ft. of lining, and this gave sufficient time for the concrete to set and become strong enough to support the superimposed load.

Six-Foot Sets Used in Uniform Ground.—During the progress of the work some unfavorable ground was encountered, and room for a 6-ft. set was impossible. In these cases, a 4-ft. set was poured, and the method as for the 6-ft. set used. Several such cases were encountered in the "A" and "C" shafts when working the surface above the ore. At every third set, when the sets were spaced 6 ft. apart, an extra divider was inserted to support a steel solar deck, which had an opening for a ladderway. Steel ladders long enough to reach from one solar to another and bolted at the foot to the deck and stiffened by struts fastened to the wall were used. These ladders are made of 1½-in. x 1½-in. x ¼-in. angles, using ¾-in. pipe spaced 12 in. on centers for rungs.

The table shows the comparison in progress made at "A" and "C" shafts:

PROGRESS MADE AT "A" AND "C" SHAFTS, TENER MINE, CHISHOLM, MINN.

	"A" shaft.	"C" shaft.
Number of weeks worked	18	19
Average progress per week, ft	16½	15½
Average progress per month, ft	75	68
Greatest progress per week, ft	30	48
Greatest progress per month, ft	112	152
Depth of concrete, ft	304	292

At "A" shaft, column openings were made at the pump station and at the level. At "C," a skip tender's drift and small pump station were concreted; also column openings for two levels. In both shafts, concrete covered I-beams were used, 15-in. beams for columns and 12-in. beams for caps.

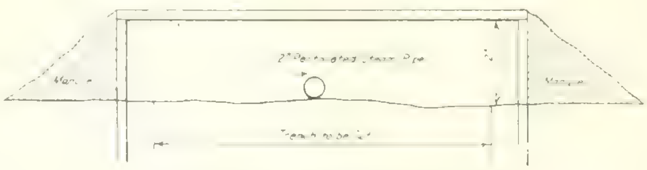
Widening Wheels of Grader for Work Over Soft Ground

A method of increasing the bearing areas of elevating graders that should be of interest to dirt movers was employed in the construction of the Sieberling Division of the Lincoln Highway across the Great Salt Lake Desert of Utah. Heavy rains made the soil so soft that it was difficult to operate the road machinery. Extra bearings accordingly were placed on the wheels of the elevating graders and the caterpillar treads of tractors. On the graders the outer ends of the planks were supported by a ring. Diagonal brace rods extended from the hubs of the wheels to the planks. The arrangement is shown in the accompanying illustration.

Padles on Wheels of Elevating Grader.

Method of Thawing Ground for Trenching

In the construction of the Rideau River intercepting sewer at Ottawa, Ont., work was carried on during the winter months. As the frost penetrated deeply into the ground, the thawing device shown in the sketch was employed. This consists of a box 6 ft. wide by 1 ft. high, and a steam pipe. The box was placed each night to cover a section of the proposed trench about 60 ft. in length—the amount that would be excavated next day. The pipe had perforations every 18 in. The steam was kept on all night at high pressure.



Thawing Device for Trench Excavation.

$1,000,000,000 Damage to Belgian Railroads—The Belgian Commission investigating damage done by the Germans to railroads in occupied territory, estimates the damage to railroad material, tracks, bridges and other equipment at more than $1,000,000,000. Nearly 690 miles of railroad tracks were destroyed and nearly 260 miles virtually destroyed and rendered useless out of a total mileage of approximately 2,600 in Belgium.

How the Cornell Society of Civil Engineers Find the Right Job for the Right Man

In view of the large number of engineers in the military and naval service the United States who will soon be candidates for positions in civil life, and in view of the awakening interest that is being manifested by various organizations in the scientific placing of men in positions which they are, by training and temperament, qualified to fill, the methods of the Cornell Society of Civil Engineers may be of considerable interest. The following description of the system developed by the registration bureau of the society is abstracted from an article by C. S. Rindfoss in the February Cornell Civil Engineer.

Nothing is more sad than to see a man doing work for which he is not fitted. Many men start on the wrong path or become sidetracked and, being burdened with a family or other private responsibilities, lack the time, capital, ability, or nerve to change to that position where their native talents have a chance to display themselves. A helping hand at this juncture pointing the way to greater opportunities, is a fine thing not only for the man but for the professions and society in general, tending to efficiency and greater productiveness.

Keeping this in mind the first step in the plan of the Cornell bureau was to catalogue every man who had ever attended the college whether he was satisfactorily employed or not, whether he was a beginner or a man of high attainments. A questionnaire was sent to every Cornell civil engineer, some 2,000 in number. The idea in cataloging all the men was: first, that in no other way could it be determined how many were desirous of a change; second, that any man at any time might become a candidate for a new position; third, that every man, practically speaking, will consider a change if offered sufficient inducement, either in salary, responsibility or chance for service; and fourth, that the sympanthy and help of the satisfied men were necessary to the bureau and that they would support a bureau more readily if they were a part of it and received the various notices sent out from time to time.

These questionnaires are four pages, letter size and are filed by number (without reference to the alphabet). All correspondence with reference to a man's record received subsequently is filed with the questionnaire, so that the questionnaire becomes a folder with complete data—up-to-date—and immediately available. Follow up cards are sent from time to time to keep the records up-to-date and these also go into the questionnaire folder.

A card index (size 3x5) is maintained to go with the questionnaires, arranged alphabetically, each card containing the name of the man and his number—nothing more. By means of this index, given a man's name, his number can be immediately determined and from the number his questionnaire is located.

Another card index, (size 3x5) is maintained which is arranged by classes. This index is divided into two main groups labeled "satisfied" and "not satisfied." Unemployed men are filed in the latter group until employed, when their cards are transferred to the "satisfied" group. Should a man become dissatisfied with his employment, his card is transferred from one group to the other without disarranging the regular files.

Each of the two main groups is subdivided by salaries. For example, cards of all men who place a value on their services of, say $250 per month, are placed between the tabs 200 and 300. Men who value their services at, say $350, have their cards placed between the tabs 300 and 400, and so on. Should a man's value increase so that his subsequent reports show that, whereas at one time he would consider a $250 position and his card was so filed, he now would consider nothing less than $350, his card is simply transferred without deranging the regular files.

Each salary group is further subdivided by symbols which indicate whether a man is a candidate for an "executive," "administrative," "engineering," "sales," "clerical," "commercial," etc., position. The card is so ruled that the symbol and salary may be changed from time to time so that without even knowing what the symbols mean the card can be placed in the right slot by a clerk with a maximum of speed and accuracy. For example, if the last symbol on a card is 1-450-NS his card belongs in the "Not satisfied" group, subdivision 400-500 (salary) sub-subdivision (executive). Further reference to the questionnaire here illustrated will show the basis of the classification on these cards.

The procedure in practice in using the file would be about as follows:

Suppose an employer calls for a man to fill the following position—

1. Superintendent of construction;
2. Salary—$450 per month;
3. Age wanted—30 to 40;
4. Type of work—factory building; reinforced concrete; pile foundation.

It would require but a moment to pick the group of cards classified Administrative—400-500. The corresponding questionnaires are then taken from the questionnaire file and those selected which represent men of about the age and professional attainments required. Any special requirement, such as "married man preferred," "man capable to design as well as construct wanted," etc., can be determined from the questionnaire. An exact copy of each questionnaire of each logical candidate is then sent the employer and the original returned to the file. A metal signal is then placed on the card of each man recommended for purposes of "follow-up." A notice is also sent to each man telling him he has been recommended for the position.

It will be seen that every effort is made to serve the employer by only sending "logical" candidates. If no man seems available, the inquiry is referred to one of the other college bureaus who reciprocate in like manner.

Many other forms and devices for follow-up purposes, for obtaining inquiries from employers, and to save dictation in correspondence, are used, but it is thought the method here explained gives the gist of such features as are novel.

The Relations Between Engineers and Contractors*

By JOHN F. O'ROURKE.

The growth of things, the necessity for having better engineers, for having larger contractors, for having a different sort of construction, for having a building lot that comprised something beyond the building that was 25 ft. front and 100 ft. deep and five stories high (which everybody who knows anything about New York building laws knows was the building law of New York up until about 1892 or 1893), all this great concentration in cities, this great growth of wealth, this great independence of depending upon somebody abroad to furnish you with plans, evolved the modern engineer and the modern contractor.

The modern contractor is the man who, even in front of the modern engineer, would be entitled to membership in the American Society of Civil Engineers, because that says in order to be an associate of the American Society you must be able to make plans and build work and that you have had at least one year's experience in independent charge of work; to be a full member, which at the present time is restricted to people over 30 years of age, you must have had at least five years' experience in independent charge of work. Now where is there a contractor who belongs to what we call the educated class who can't fill that bill? So when I talk about the relations between engineers and contractors, I don't want it to be understood that the engineer I mean is the man that makes the plans, and the contractor I mean is the man the engineer tells how to carry out the work, because that is what they did in the very beginning when it was easy. I am going to talk about the engineer and the contractor in the sense of the two parties to the contract.

There is first the owner and his representative, the engineer; and the engineer is to tell the contractor everything that the specifications say and everything that the plans mean, and if there is anything missing he can tell him a great deal more than anybody else can tell him that they mean. That is where we get down to what I am talking about now as the relation between the engineer and the contractor. The thing that appeals to many engineers that started a good many years ago, was the fact that in making their plans they had a great deal more trouble in having them carried out than if they did the work themselves.

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*[illegible] at the [illegible] of the [illegible] Contractors of America.

[illegible] engineers. That is, the engineer whom the [illegible] the party [illegible] who makes the [illegible]

[illegible] national societies than if he were very obscure in the profession.

[illegible] who have gotten to [illegible] office [illegible] and many of them, of course, are among the most eminent men in the world. But [illegible] if one of them resigns [illegible] a consulting fee here and there, has a chance to do something real [illegible] a contract his first duty to that organization is to resign—no longer is he eligible.

[illegible] a feeling that if a [illegible] the original plans (however shadowy they may be as to the final execution of them), unless he belongs to that party of the first part, he is not, strictly speaking, an engineer.

[illegible] part—engineers and the party of the second part—engineers. It is safe also to say that in one case they are so underpaid that I don't know any class of professional men who are so much the victims [illegible] engineers in America. The [illegible] there are four dimensions. A lot of people are greatly troubled to know where the fourth dimension is. Unless they are very poor indeed, they've got it in their pocket.

[illegible] and thickness from that you get quantity. Multiply that by this thing that you may have in your pocket as the fourth dimension, then you get cost. You get everything that applies really to the practical side of anything because you can't talk about building billion dollar [illegible] to get down to something that is practical; you've got to get down to something within the bounds of railroads or ten billion dollar courthouses or anything that reason, compared by the standards of the fourth dimension. Also you've got to get that fourth dimension in before you get any dimension at all on a contract as a contractor. You din't count if it is too large, and that's what I'm after.

The thing that I've got in my mind outside of the organization of this body, the making of an association in which all the contractors of the United States will get their rights made known and their power felt and their possibilities of doing good—get that all in national dimensions both for [illegible] other kind of a structure. I am getting after the engineers where they will get something and where among other things they will get out of their shell and come out and shake hands with the fellow that is showing them how the work is being done because most of them know nothing about it.

They are simply the products of the civil service which takes into view the capability of answering a lot of theoretical questions, most of which don't apply to engineering at all and which is one of the curses today of doing work for any body that is covered by civil service.

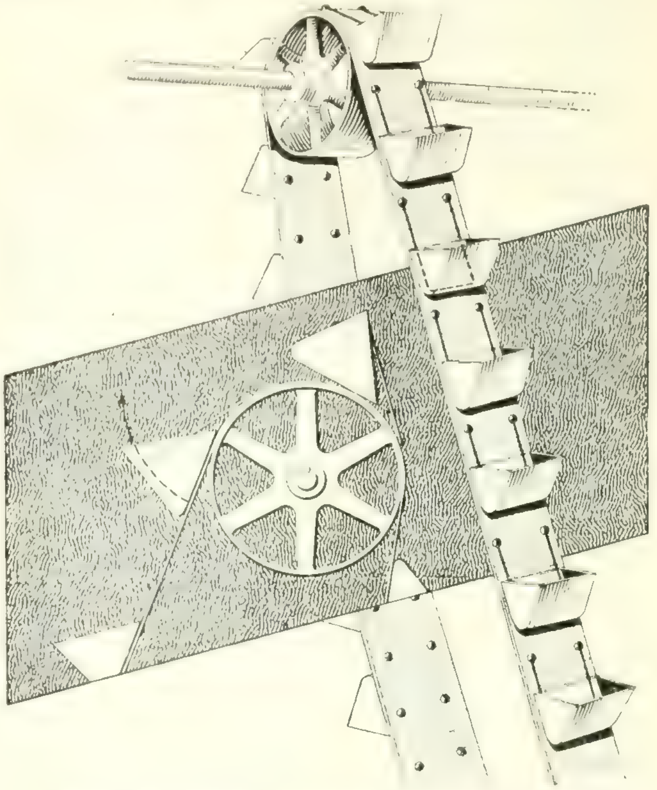
We have got to broaden ourselves; we have got to have contracts in which there will be something more than the statement that the engineer is the sole judge without pro[illegible] judged as to his judging. We've got to make the contractors free in the sense that when they undertake to do anything and feel honestly that they are going to do it and that they are going to do it in the best and most efficient way, that they will be able to do that without having somebody that does not know anything at all about the work starting in to tell them how they shall do it wrong.

The only way this can be done is to make ourselves felt as a body of contractors, a body of contractors who (as my first definition states) are really a body of engineers. They are called contractors because they draw the thing together, not because they draw them. Note the difference. And we've got to have it so that whether a man is on one side or the other, it has got to be fully understood that there is a particular side that he is on and that they are all on, and that is the efficient, economical, rapid performance of the work. This is more to the owner than it is to the engineers of either side and it is more to the people in general than it is to the owner.

Automatic Elevator Bucket Discharge

A simple device for procuring discharge of the bucket when the material elevated has a tendency to pack in it is described by Mr. H. M. Schleicher in Engineering and Mining Journal.

The method is illustrated in the accompanying sketch. A given point on the belt starts around the head pulley before any point below it. The ends of a wire U-shaped loop are fastened to the belt just above a bucket and project down into the bucket. As the ends of the loop start around the head pulley, the bottom of the loop describes an arc across the bottom of the bucket. Furthermore, and more important, as the ends of the loop leave the head pulley on the down side, the action is reversed, and at this time the bucket is inverted and in the proper place and position to discharge.



Device for Insuring Automatic Discharge of Bucket.

The wire loop is provided with eyes at the ends of its arms, by which it is fastened to the belt with small belt bolts over large washers. The bottom of the loop is made to conform closely to the form of the bucket. The loop should be of such length that it does not touch the bucket anywhere, either when the belt is straight or giong around a pulley; that is, the arc described by the bottom of the loop should be shorter than the distance across the bucket. The bucket, in traveling around the pulley, remains tangent to it and does not change in relation to the belt at any time, although the loop does change in its relation to the bucket when it starts around and again when it leaves the pulley. The first sweep of the loop through the bottom of the bucket loosens its load and the second sweep, taking place while the bucket is inverted, insures discharge.

Trials of this method were made with ordinary telegraph wire bent into shape by hand around four nails driven into a mill post. The nails were positioned so that the wire, when bent around them, took the desired shape, and by removing the heads of two of the nails the eyes on the loops could be made at the same time. These loops were tried at varying lengths until the proper length was ascertained. Those made of soft wire did not show much wear after two months' operation, but were rather soft for the best work. They tended to bend, which would be avoided if spring-steel wire were used. Loops made of steel should give long and satisfactory service.

The device will work satisfactorily on fine, wet materials. The wire should be stiff enough to penetrate the load, and should be fastened to the belt over the large flat washers. As the material in the buckets has little opportunity to pack, the wire need not be as thick as would at first thought seem necessary.

It is desirable to find the correct length of the loops so as to avoid contact of the wire and the bucket. In order to have a starting point for ascertaining the proper length, the following formula, which gives the approximate length, is offered: Let D be the diameter of the head pulley in inches. Measure the distance from the tip to the back of the bucket, divide by two and call this W. Then L [illegible] Dw + W = length of the loop. This can be only approximate, as the shape of the buckets varies and in deriving the formula the loop is assumed to be in a position which may hold good only for a particular case. It will be necessary to adjust one loop properly and then make the remainder the same, both as to length and the distance the loop projects into the bucket.

Equating Track Section for Maintenance of Way Work

Labor constitutes the largest single item of maintenance of way expense; in fact, it is larger than all other expenditures combined, aggregating approximately 56 per cent of all charges of this department. From its nature it is the expenditure in which there is the greatest opportunity for the display of economy and likewise the greatest danger of waste and inefficiency. It would, therefore, naturally be expected that the distribution of this expenditure, aggregating over $500,000 a day, would be surrounded with elaborate safeguards to insure the greatest return. Yet investigation shows that the reverse is true. As a result, the allotments are commonly made on an arbitrary basis of so many men per section, with only very general consideration of the relative amounts of work to be done. This question has been considered by the Committee on Economics of Railway Labor of the American Railway Engineering Association, and in a report submitted March 18 at the 20th annual convention of the Association, the following information was given:

In general, section limits have been established by giving each gang an equal mileage of main line with whatever auxiliary tracks come between these limits. The gangs are then allowed an equal number of men. The result is that some gangs have much more work to perform than others because of unequal mileages of sidetracks and special local conditions. With an unequal distribution of the work, it is evident that the greatest return is not being secured from the total expenditure and loss occurs.

The importance of equating sections on a more equitable basis has been recognized for years and some study has been given to its solution. As a result, certain more or less arbitrary ratios have been established on a few roads, and while perhaps crude and inaccurate, are a step in advance of the common practice.

Thus, on the New York Central two miles of sidetracks, or 15 switches, are considered equivalent to 1 mile of main track. Allowance is also made for special local conditions, such as soft subgrade, high rock cuts, excessive curvature, character of traffic, etc. An ordinary section is given about six equated miles of main track.

On the Southern Pacific 2 miles of branch lines, or 4 miles of sidings, are considred equivalent to 1 mile of main line. Sixteen switches are also considered equivalent to 1 mile of track of the kind in which the switches are placed. Consideration is also given to the nature of the rail, ballast, curvature, density of traffic, etc.

On the Cleveland, Cincinnati, Chicago & St. Louis track sections have been equated where the line has been double-tracked, the length of such sections being made equvalent to 6 miles of single track on the following basis: Second track, 85 per cent of main track; passing tracks, 50 per cent of main track; yard tracks in heavy terminal yards, 50 per cent; other sidetracks, 30 per cent; turnouts, each equivalent to 300 ft. of main track.

On the New York, New Haven & Hartford a mile of main track has been taken as a unit. Two miles of sidetrack, or 15 switches, are considered equivalent to 1 mile of main track. The various lines of this road have been classified between main line, secondary main line, and branches, partially on the basis of the tonnage passing over them and in part on the importance of the lines from a passenger standpoint where the tonnage alone is not sufficiently heavy to bring them into what is considered the proper class. Different allowances of men per equated track mile are made on the lines of these different classes, consideration being given to the fact that on divisions of two and four tracks the shorter distance sectionmen have to go compensating them slightly for the heavier traffic.

An equation was worked out on one division of the Michigan Central about five years ago, covering 300 miles of single main track and 500 miles of branch tracks and sidings. As the result of a 12 months' study of the actual distribution of work on this division, the following relations were established, 1 mile of single main track being considered as the unit:

	Per cent.
[illegible]	100
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

On the Toledo division of the Pennsylvania Lines West of Pittsburgh, consisting almost entirely of single track, with only a small amount of second track, 1 mile of main track is considered equivalent to 3 miles of sidetracks, 4 miles of yard tracks, 20 main line turnouts, 40 turnouts in side and yard tracks, 25 railroad crossings, 40 public highway crossings and 60 private crossings.

The Baltimore & Ohio has given careful attention to the subject of equating track sections in connection with the development of its standard track work system, as the determination of standard performances is essential to the computation and payment of bonuses. The details of this system, including the determination of units of track work, were described in a monograph by Earl Stimson, published in the Proceedings of this Association for 1916.

The Grand Trunk has given careful consideration to this problem. Based upon its extended studies, the following basis has been approved for equating track forces:

[illegible]

STANDARD FORCE

[illegible]

[illegible] 0.33

A Single [illegible] 4 [illegible] 0.50 1.50

Single [illegible] 1.75

[illegible] 1.75

Single [illegible] line S [illegible] 2.67

[illegible] 1.00

[illegible]

Winter 3 per cent

[illegible]

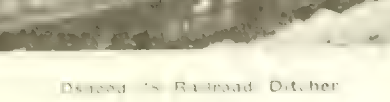
The Osgood 18 Railroad Ditcher

The railroad ditcher is the "[illegible] of all work" in the maintenance of way field. Primarily designed for side ditching, it [illegible] in miscellaneous excavation and in various other operations, depending upon the need of the moment and the ingenuity of the operator. The accompanying illustration shows the Osgood 18 railroad ditcher [illegible] three independent sets of engines for controlling the hoisting, swinging and crowding motions. It is self-propelling in either direction with double axle drive, and revolves in a complete circle. The hoisting engines are double $5\frac{1}{2}$-in. bore x 6-in. stroke with link reverse. These engines are arranged horizontally and spaced apart sufficiently so the hoisting drum can be mounted up between and supported on the engine bed. The swinging engine is double cylinder, $4\frac{1}{2}$-in. bore x 5-in. stroke, reversible by central valve. The boom engines are duplicates of the swinging engine. The ditcher has a $\frac{3}{4}$ cu. yd. dipper, a 17-ft. dipper handle and a 17-ft. boom. The specified digging radius at 8-ft. elevation is 28 ft. 6 in.; height of dump from top of flat car 8 ft.; dumping radius, 26 ft. 9 in.; digging depth below top of flat car, 11 ft. The ditcher is made by The Osgood Co., Marion, O.

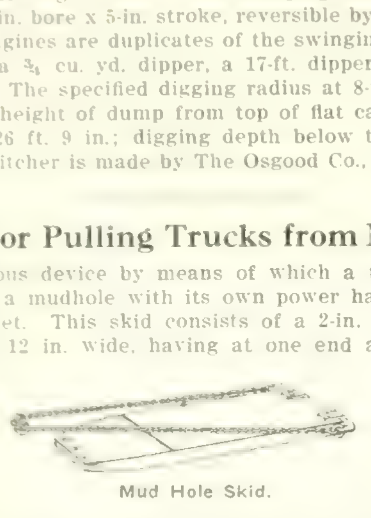
Osgood 18 Railroad Ditcher

Device for Pulling Trucks from Mud Holes

An ingenious device by means of which a truck can pull itself out of a mudhole with its own power has been placed on the market. This skid consists of a 2-in. board about 6 ft. long and 12 in. wide, having at one end a bar of ¾-in. iron bent to shape and fitted with rings to which a chain is attached. The chain is passed through the wheel spokes, as indicated in the cut. When the engine is started the wheel travels along the board and also pulls the board underneath, thus enabling the truck to pull out of the mudhole.



Mud Hole Skid.



Skid Attached to Truck Wheel.

The skids also can be used in backing out, and in cases of emergency the chains can be detached and used as skid chains. The device is known as Moore's Mud Hole Skid. It is manufactured by Langley & Schultze, 426 S. 3d St., Louisville, Ky.

Personals

A. A. Mathews has been appointed chief engineer of all lines of the St. Louis Southwestern R. R.

William S. Wilson has been appointed division engineer of the Pennsylvania R. R., with headquarters at Oil City, Pa.

E. L. Martin has been appointed chief engineer of the Missouri, Kansas and Texas, Omaha Belt and Missouri, Oklahoma and Gulf; Dallas, Missouri, Kansas and Texas of Texas, Wichita Falls & Northwestern Railroads.

Harvey L. Gamer, electrical engineer for the Union Pacific R. R. has resigned and will move to a farm of 210 acres that he has purchased in Cass county, near Louisville, Neb. He is succeeded by Edward E. Hegensick, formerly in charge of overhead work on the Omaha street railway lines.

F. G. Jonah has been appointed chief engineer of the St. Louis-San Francisco, Kansas City, Clinton and Springfield, Paris and Great Northern, West Tulsa Belt, Rock Island-Frisco Terminal; Fort Worth, St. Louis San Francisco and Texas, Fort Worth and Rio Grande, Brownwood North and South, Quanah, Acme & Pacific Railroads.

William C. Perkins, for the past six years chief engineer of The Dunn Wire-Cut Lug Brick Co., of Conneaut, O., has been elected chief engineer and general manager of the Eastern Paving Brick Manufacturers' Association, comprising 35 companies, with shipping territory covering Pennsylvania, West Virginia, Maryland, Delaware, New Jersey, New York and the New England states. Headquarters will be established in Philadelphia. Mr. Perkins was formerly resident engineer at Buffalo for the New York State Highway Commission. He went with the Dunn Wire-Cut Lug Brick Co. in [illegible].

Arthur H. Blanchard, consulting highway engineer, has been appointed chief of the Bureau of Public Works Department of Citizenship under the Army Overseas Educational Commission. General Pershing has requested the Y. M. C. A., through its commission, to take charge of the development of instruction and courses for all educational work of the Army overseas. The staff of the Bureau of Public Works and Army instructors in 500 post-schools throughout France will give lectures and courses relative to waterways, railways, highways, bridges, water supply, sewerage, waste disposal, public utilities and irrigation. Special emphasis will be placed on the economic value of good roads to the nation, state, county and town, and on efficient methods of highway, railway and waterway transportation.

Obituaries

Carl B. P. Ekvall, formerly borough engineer of Torrington, Conn., died March 8, aged 72.

Charles Whitehead, a railroad contractor of Western Canada, died March 10 at Brandon, Man., aged 83. He carried out several contracts for the Canadian Pacific Ry. on the main line and on the prairies as well as in the Rockies and along the north shore of Lake Superior.

John S. Wolf, a pioneer railroad builder of the Middle West, died March 5 at Cedar Rapids, Ia., in his 100th year. He learned the trade of blacksmith and wagon maker but when the first railroad was to be built out of Harrisburg, Pa., near his home, he engaged in that work and continued in the business during the rest of his active life. He helped build some of the first sections of the Pennsylvania road west of Harrisburg, then went to Ohio and in 1856 came to Iowa, building the first railroad into Cedar Rapids. At the time of the Civil War he was in Wisconsin building roads at the direction of the government. He was later the builder of the old Cedar Rapids, Burlington and Northern road from Cedar Rapids to Grundy Center, and of the North Western west of Cedar Rapids, to Marshalltown and Ames. He also did a great deal of work in Missouri, Kansas and Minnesota.

Industrial Notes

The Chicago Pneumatic Tool Co. has opened offices and warehouses at Tulsa, Okla., and El Dorado, Kan. The Boston, Mass., offices and warehouses have been removed to 182 High St.

The Sullivan Machinery Co. has established a branch sales office and warehouse at Edificio Oliver No. 3, Mexico City, Mexico. Joseph F. Bennett, for a number of years, sales engineer in Mexico, associated with the El Paso branch of the company, has been placed in charge of the Mexico City office.

The Sullivan Machinery Co. announces the appointment of Chester Mott as manager of its branch office at Denver, Colo., 837 Equitable Bldg., succeeding Wallace T. Roberts, recently resigned. Mr. Mott has been associated with this company for several years past in the capacity of sales engineer at its Spokane, Wash., office, and more recently at its Chicago office in charge of the company's interests in Iowa, Northern Illinois and Minnesota.

The Chicago Pneumatic Tool Co. announces the following appointments: J. I. Edwards as manager rock drill sales division, succeeding E. Eklund, who has been appointed special foreign representative and who will leave shortly for Europe in the interests of the Company. Fred H. Waldron, formerly Minneapolis representative, has been appointed manager pneumatic tool sales division, succeeding J. G. Osgood, resigned. Mr. Waldron's offices are now at the company's headquarters in the Fisher Bldg., Chicago. Nelson B. Gatch was recently appointed district manager of sales at Minneapolis, with offices at 301 Metropolitan Bank Bldg. J. K. Haigh has recently been appointed assistant district manager of sales at the San Francisco office at 175 First St.

Trade Publications

The Lakewood Engineering Co., Cleveland, O., has issued a new 24-page bulletin describing its clam shell buckets.

The J. D. Fate Co., Plymouth, O., has issued two bulletins devoted to descriptions of the use of the Plymouth gasoline locomotives on construction work.

The Ingersoll-Rand Co., New York, has issued a 24-page catalog on Imperial Tie Tamping Outfits. Catalog is profusely illustrated, showing application of the tie tamping outfits on many of the important railroads in the United States.

The Insley Manufacturing Co., Indianapolis, Ind., has brought out a 20-page bulletin describing its steel guy and stiff leg derrick. Details of the equipment are illustrated and described. The bulletin contains a useful table indicating the number of sheaves required to lift certain loads with given engine pulls.

The Pulsometer Steam Pump Co., 222 W. 42nd St., New York City, has just issued a 52 page catalog of the Pulsometer steam pump. It contains numerous illustrations of interesting installations on construction jobs, and information on the cost of pumping. Several pages are devoted to descriptions of applications of the pulsometer to various classes of work.

Building and Structural Issue

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The *articles* in the first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering and contracting field. The *articles* in the first and last issues of each month (1st and 4th Wednesdays) completely cover county engineering and highway engineering and contracting. The *articles* in the third and last issues of each month (3rd and 4th Wednesdays) completely cover steam and electric railway location, design and construction. See the "mast head" on the first page of the Weekly News Section for information about our weekly contract news. See Advertising Page 55 for Subscription Coupon.

Roads and Streets—1st Wednesday
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power

Railways and Excavation—3rd Wednesday
(a) Excavation and Dredging (c) Quarries and Pits
(b) Rivers and Canals (d) Railway Construction—Steam and Electric

Buildings and Structures—4th Wednesday
(a) Buildings (c) Harbors Structures
(b) Bridges (d) Miscellaneous Structures

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Are War Wages Consistent with Peace Prices

While one department of our federal government has been telling us that we need not look for lower prices, another department has been urging manufacturers of steel, cement, lumber and other building materials to make substantial price concessions. The Department of Labor had no sooner published Prof. Irving Fisher's report stating that the present high price level is here to stay than Secretary Redfield announced that the steel manufacturers have agreed to 10 to 15 per cent reduction in prices.

The Department of Labor is obviously worried over the increasing surplus of idle labor, and in its effort to stimulate construction activity is telling the investing public to begin building at once because nothing will be saved by waiting. The department finds a well known political economist whose theories jibe with the department's desires, so it issues bulletins such as "The New Price Revolution," by Prof. Irving Fisher of Yale. Prof. Fisher argues that the great influx of gold and the increase in circulating credit completely explain high prices and assure their permanence. He says:

"The fundamental practical question confronting business men is whether the general level of prices is going to fall. In my opinion, it is not going to fall much, if at all. We are on a permanently higher price level, and the sooner the business men of the country take this view and adjust themselves to it the sooner will they save themselves and the nation from the misfortune which will come if we persist in our present false hope.

"The availability of the vast issues of war bonds as bases for future credit expansion, coupled with the fact that our banking system has still many unused reefs, sure to be taken out later, when business wishes to spread more sail, is the chief reason why prices will keep up permanently; that is, for many years.

"Business men should face the facts. To talk reverently of 1913-14 prices is to speak a dead language today. The buyers of the country, since the armistice, have made an unexampled attack upon prices through their waiting attitude, and yet price recessions have been insignificant. The reason is that we are on a new high-price level, which will be found a stubborn reality. Business men are going to find out that the clever man is not the man who waits, but the one who finds out the new price facts and acts accordingly."

Business men cannot forget, however, that the predictions of political economists relative to the economic effect of the war have proved to be wrong in many respects.* Moreover, business men realize better than professors of political economy that "commercial credits" are not the primary cause of high prices. Increasing demand for labor and products precedes an increase in "credits"; hence "credit money" is only a later link in the cause-effect chain.

The leading banking houses that issue bulletins have been forecasting a drop in prices followed by a drop in wages. They have avoided predicting when this drop will occur. Business men are apparently in accord with the opinions of the bankers.

If the influx of gold into America has been a large factor in raising prices here, as the political economists affirm, then why has the efflux of gold from England not lowered prices there? The fact is that prices in England have risen more than in America. The cause is evidently the war demand for materials and labor. Now that that demand has disappeared, there is a deadlock between workers and employers, the former demanding maintenance of war wage schedules, the later hesitating to cut prices because of this demand, yet fearful of not securing adequate business orders unless a cut is made.

American copper producers have reduced the price of copper nearly 40 per cent since the war ended, but they are [illegible] the average output of American work- [illegible] this statement. Obviously if the average output is [illegible] the price level will fall greatly. Instead of forcing [illegible] the attempt should be made everywhere to force output up. Employes should be induced to join in this effort. [illegible] all hope to secure shorter working hours and a larger share of worldly goods.

It may be that the coal miners of England will force the [illegible] week and pay twice as much per ton for coal as is now paid in America. But [illegible] only at the expense of other English workers. Then other unions will retaliate, and in the end the condition of the average English worker will be worse than it was before the war. It will approach the condition of many Russian bolshevists, who, having cut out working almost entirely, find that their enormously high wages fail to keep them far from the brink of starvation.

What the Fiasco Conference of Governors and Mayors Should Teach Engineers

[illegible] a single bill providing for public works on a large scale; and the President has said that he will not call a special session till he returns from Europe. Fortunately it is likely that this will occur within four or five weeks. By that time it will be even more evident than it is now that the federal government should make large appropriations for public works.

It was well that the President called a convention of governors and mayors and urged them to advocate large programs for public improvement. But it was not a good example that he set when he failed to outline a similar program of federal construction.

It is significant that though the President asked governors and mayors to discuss ways and means of providing work for returning soldiers he did not ask the engineers of America to outline what should be done. Civil engineers in every case must plan the proposed public improvements. Then why were the planners ignored when state and city political leaders were asked to confer upon public works programs? Clearly the time has not yet come when an American president can be expected to look beyond the political executives [illegible] public works—the engineers. So it behooves civil engineering societies to force themselves upon the attention of the President and other political leaders. Engineering societies should prepare definite programs for public improvements. They should not wait for less competent men to initiate programs of this sort.

The almost complete fizzle of the governors and mayors' conference is sufficient evidence of the inability of political executives to prepare a definite program for public improvements. Some 20 governors and 135 mayors listened three days to the oratory of a few lawyer politicians, drew up a set of high sounding resolutions and went home little wiser than they came. How could it have been otherwise? First, they did not have time to prepare adequate programs for public works. Second, they were not personally competent to prepare such plans, no matter how long the time consumed. The only class of men competent to execute such a task, the engineers of America, were not even asked to mail in a suggestion. Yet we engineers have been congratulating ourselves that the war had at last made it clear to the public that back of every great modern achievement is the man of [illegible] a very small part of the public perceives this fact, and it is not the political part that perceives it.

Will the "Mucker" Become the Aristocrat of the Labor World?

[illegible] had an abundance of "common labor" in this country until recently, we have become so habituated to paying low wages to that class that it causes somewhat of a shock when it is suggested that the day may be at hand when there will no longer be any cheap common labor in America. In his "Looking Backward" Edward Bellamy pictured a time when men engaged in the most menial work would receive the highest pay. In Bellamy's Utopia the streetsweeper, the pick-and-shovel man, and all that onetime host of dollar a day laborers had ceased to be recipients of crumbs from their masters' tables, and had become the aristocrats of the working classes. Twenty-odd years ago we smiled at that bit of fantasy. Would we smile so broadly at it today?

The wages of the common laborer in America now average about $3. With immigration prohibited for five years, as has been seriously proposed, it is probable that common laborers would soon receive $5 or more a day. Why not? If the supply of men willing and able to do hard muscular work dwindles relatively to the demand, it may readily come about that common laborers will receive higher wages than clerks or carpenters. Indeed, it is conceivable that these gladiators of toil may eventually be envied for their strength as were the ancient gladiators of the arena. Has it not been said that "the lowly shall be exalted?"

In metal mining districts the "muckers" who do the heavy work of loading the ore already earn almost as much as the skilled drill runners. What man would not sooner run an air drill than shovel rock? So a moderate decrease in emigration may readily result in there being more men able and willing to run drills than those willing to "muck." If that time comes we shall see common "muckers" earning higher wages than skilled drillers.

One thing is already certain, there is no longer any considerable number of low priced common laborers in America. At the time of our revolutionary war common laborers received 50 cts. a 12-hour day. Now they receive $3 to $3.50 an 8-hour day. Their wage rate per hour has increased ten-fold. And the buying power of a dollar is fully half as great as it was then, if we consider all the things that the average person buys.

Some Useless Psychological Tests

It is announced that Columbia College is about to abandon the old style of examinations and substitute psychological tests to determine the mental fitness of applicants for admission. Each applicant will be required to show a graduation certificate from a high school or its equivalent, and this will be the sole criterion of his fitness by virtue of having studied the standard subjects. His fitness to continue as a student is to be determined by measurements of his mental qualities. The measurements are to be similar to those used by the professional psychologists in their examination for admission to the Students' Army Training Corps, we are told.

Psychological tests of this sort have been published recently in several magazines, and some of these will be reprinted in our next week's issue. Our readers will then be able to gage their practical utility. Our own conclusion is that these psychological tests are at best merely crude attempts to weigh mental ability. That they serve to show whether a man is habituated to use language intelligently is admitted, but that they distinguish strong from mediocre mentality we deny.

But this is the day of the psychologist, and in the name of mental science he is offering the public many an alleged short cut to knowledge about our fellow man's gray matter. It will be well to read what the greatest American psychologist, James, said a few years ago in his "Talks to Teachers on Psychology." He stoutly maintained that the brain is too complex an organism to permit analysis of its capabilities by any simple set of tests.

In our next week's issue we intend discussing the logical absurdity of some of the methods of measuring a man's mental fitness with psychological calipers.

What Shall Be Done with the Engineering Pamphlet?

To the Editor: I note with interest the articles on pages 206 and 209, respectively, of your issue of Feb. 26 concerning the pamphlet and I hope you are going to get some light upon the subject for Mr. Fleming and everyone else. These questions, "How shall the existence of a pamphlet be made known to those who would be interested in it?" and "What shall be done with the pamphlet?" seem to be very much to the point. Let me offer the following suggestions:

1. That we consider the possibility of having an index service somewhere in this country that would specialize on pamphlets.

2. That we try to have a center, perhaps the same one, from which pamphlets of all descriptions can be loaned at 1 ct. a day.

3. That people publishing pamphlets should send a residue of upwards of ten to H. W. Wilson Co., 958 University Ave., New York City. I published a pamhplet in 1907 entitled "The Library and the Business Man." "When the supply was about exhausted I sent them 10 copies, suggesting that they charge 25 ct. apiece for them. I believe they do this and I am very glad to have them keep the money. When people nowadays want a copy of "The Library and the Business Man" I refer them to H. W. Wilson Co. and they probably get it for 25 ct. This, you see, furnishes an elastic method of hanging onto waning editions.

The pamphlet problem should be put up to the American Library Association for consideration by a special committee and action at its annual convention. It is a problem that bothers everybody.

I am sending a copy of this letter to Dr. William Warner Bishop, who is president of the American Library Association and is librarian of the University of Michigan, Ann Arbor. I hope he will have some suggestion to send you also.

G. W. LEE, Librarian,
Boston, Mass. Stone & Webster.

Engineering Societies and Constructive Legislation

To the Editor: On the principle that a constant dripping of water will wear away stone, it is possible that eventually the engineering profession will become aroused to the necessity of taking a more active part in the initiation and framing of fundamental constructive legislation, providing a few enthusiasts like yourself apply an irritant at frequent intervals.

Here in Missouri, we are confronted today with the spectacle of important road legislation pending while the several engineering societies in the state, oblivious to their opportunities, are making no effort to impress upon the legislature a few fundamental facts and principles, upon which such legislation should be based for the greatest benefit to the public.

One of these facts is that the selection of routes, the determination of lines and grades, the designing of pavements, bridges, and culverts and supervising their construction are all very largely engineering work and should be handled by an engineering organization. While road boosters are needed for arousing public interest in a road project, a different kind of talent is needed to carry on the technical end of road building.

If the engineering talent is made subservient to a group of politicians and a board of laymen, the better type of engineers are driven away by such hampering conditions and the result is detrimental to the entire road organization. There is no more reason for a highway department to be hampered by the presence of non-technical men in its organization than there is for the Attorney General's office to be under the control of a board of laymen. It would seem that the engineering profession could openly support such a sentiment without a dissenting voice. Yet the opportunity passes by and the engineers fail to react.

To get a proper and efficient engineering organization, it must be removed as far as possible from political influence and must be headed by a competent engineer who has specialized in road work and who has had executive experience in addition thereto. Such an engineer should have the endorsement of his professional brethren. The selection of such a man can best be made by allowing each of the various engineering societies of the state to furnish to the Governor a list of eligibles. From these lists, the Governor would choose the man having the highest recommendation of his profession throughout the state. The engineer so selected should, by virtue of his office and the responsibilities resting upon him, be the head of the highway department, or chairman of the board, if one exists, and on a par at least with the other commissioners.

Is there an engineer worthy of his profession who cannot unqualifiedly support such a proposition?

Kansas City, Mo. ROBERT C. BARNETT.

Demobilization of Engineer Regiments

To the Editor: On page 232 of the March 5, 1919, issue of Engineering and Contracting there appeared an editorial headed, "Why Engineering Regiments Should Be Mustered Out at Once," in which you say: "In this connection we wonder how rapidly the engineer regiments are being demobilized. If adequate preparations are to be speedily made for construction work, thousands of engineers still in the army should be permitted to return to civil life and to their old positions without delay."

It may interest you to learn that all of the engineer regiments in this country on the date the armistice was signed, Nov. 11, 1918, have been demobilized, with the exception of the 8th, 9th, 210th and 220th Engineers, also a few small detachments. The first two are regulars on duty on the Mexican border; the 210th and 220th Engineers are now under orders to be demobilized. The 5th Engineers, Regulars, arrived at Hoboken, N. J., from overseas Feb. 25, 1919, to relieve the 210th and 220th Engineers. The men in the 5th Engineers that are eligible for discharge will be released at once. Speaking broadly, all engineers returning from France are immediately discharged except those men that enlisted prior to April 1, 1917, or elect to remain permanently or temporarily in the military service.

Demobilization has been carried on at such a rate that there is a prospect of a serious shortage of men to properly guard valuable property, equipment and records, including all the records of the local boards throughout the country stored at one of the engineer stations, until such time as recruits are received under the recent Act of Congress authorizing enlistments for the regular army. The scarcity of enlisted men is such that at one engineer post where the usual garrison is 1,200 men there will shortly be only about 200 men available for guard and all other purposes; at the principal engineer camp where the ordinary garrison is 20,000 men there will be less than 2,000 left. The engineer activities at other training centers have ceased because the engineer units at them have been disbanded.

The engineer organizations in the American Expeditionary Forces are being sent home as rapidly as the situation in Europe will permit and transports are available.

You are probably aware that all engineers entering the service during the war did not join engineer regiments; many of them went into other branches of the service and into the Navy. It is not practicable to select them for preferential release.

It is possible that you are chiefly concerned in the release of engineer officers. It is safe to say that there is not a single engineer officer, commissioned for the emergency, in this country who is being held in the service against his will.

FREDERIC V. ABBOT.
Brigadier General of Engineers.

Unit Displacement of Commodities.—The U. S. Bureau of Standards, Washington, D. C., has published a circular containing a comprehensive list of commercial commodities arranged alphabetically, giving the weight per cubic foot, cubic feet per long ton, cubic feet per short ton, and in many instances how the commodity is packed for shipment. The information is primarily intended for use in estimating cargo and warehouse space requirements.

Design and Construction Features of Concrete Oil Storage Tanks

[illegible] N. Y.

[illegible] years ago, the construction of [illegible] oil tanks [illegible] it might be possible to satisfactorily design and construct a [illegible] oil tank. Since that time [illegible] tanks have been [illegible]. A minute examination of these tanks from time to time was made [illegible]. In addition, the [illegible] States Department of [illegible], Office of Public Roads, [illegible] per cent, by weight, [illegible] to determine whether [illegible] waterproof. These experiments proved that oil did not cause disintegration of concrete, which was the former belief of many. Therefore, the engineer and contractor concluded that mineral oil tanks must be designed correctly; the concrete proportioned correctly, and mixed and placed correctly, in order to secure permanent and satisfactory results. By satisfactory results is meant that there shall be no leakage or seepage whatsoever. This conclusion has been put into actual practice and the result is that today we have several hundreds of concrete oil tanks that are absolutely successful.

The successful construction of a concrete oil tank is dependent upon: (1) the design, (2) using only good materials, and (3) exercising great care in doing the work.

The design should be made only by a competent, concrete designing engineer or architect, or one thoroughly capable for this work. There is a diversity of opinion among designers as to how much stress the reinforcing steel should be computed to withstand. In common practice the range of strength for the reinforcing steel varies from a maximum of 16,000 lb. per square inch, to as low as 6,000 lb. per square inch. This, of course, is very indefinite. It has been learned by tank building experience that the steel should be figured for a fiber stress of 10,000 lb. per square inch. It is considered good practice to compute the required amount of temperature reinforcing separately. By this is meant that the required temperature steel should be computed and placed in addition to all other steel. This, of course, is different for each tank according to the location. The temperature range should be ascertained and the greatest variations used, in computing the required temperature steel. The designer should visualize the construction as he works and plan to make the placing of concrete as simple as possible. This can often be accomplished by using rods of a larger size, which leaves a greater space for placing the concrete, and in many other ways the [illegible] can be of material assistance to the constructor.

Fig. 1.—182,000-Gal. Fuel Oil Tank of American Brakeshoe Co., Erie, Pa. Designed and Built by Con-Oil Tank Co., Pittsburgh, Pa.

How to Determine Good Sand.—Too much care cannot be exercised in [illegible] a good grade of clean, well-graded sand. A large number of concrete failures can be directly traced to the [illegible] of poor sand and not to the design or to the methods of construction. A good sand consists of natural sand or screenings, from hard, durable, tough, crushed rock or gravel, composed of quartz grains or other hard material, graded from fine to coarse, with the coarse particles predominating. Sand, when dry, shall pass a screen having four meshes to the linear inch; not more than 25 per cent shall pass a sieve having 50 meshes per linear inch; and not more than 5 per cent shall pass a sieve having 100 meshes per linear inch. Sand containing vegetable or other organic matter should never be used; neither should one containing more than 3 per cent (by weight) of clay or loam be considered. If the sand in your community meets these requirements with the exception of the clay or loam content, then you can utilize the same by resorting to washing, for which you can inexpensively construct a good sand washer.

Fig. 2—Interior View of Fuel Oil Tank of American Brakeshoe Company.

How to Determine Organic Impurities.—Fill a 12-oz. prescription bottle with sand to the 4½-oz. mark. Then add a 3 per cent solution of (NaOH) sodium hydroxide (which you can buy at nearly all drug stores), until the volume of sand and solution after shaking, amounts to 7 oz. Shake the contents thoroughly and let stand for 24 hours. If the solution resulting from this treatment is colorless or has a light, yellowish color, the sand may be considered satisfactory, insofar as the organic impurities are concerned. If you find a dark colored liquid above the sand, wash the sand thoroughly to remove the organic impurities.

Well Graded Crushed Stone or Pebbles Should Be Used.—The crushed stone or pebbles must be clean, hard, tough and graded in size, free from vegetable or deleterious matter. The size should preferably range from 1 in. down to not more than 5 per cent passing a screen having 4 meshes per linear inch, and no intermediate sizes shall be removed. The objection to crushed stone or pebbles larger than 1 in. is the difficulty of being able to properly work these larger sizes in and around the steel reinforcing rods.

Water.—Undoubtedly, much inferior concrete is produced by using too much water. We have not, until quite recently, been able to intelligently appreciate just what it means to use an excessive amount of water. Recent laboratory experiments show that a wide range in compressive strength of concrete at the age of 28 days, was obtained by using the same mixture of concrete (concrete mixture 1:4 ft., aggregates graded [illegible] 1¼ in.; mix 1 minute; 1 bag mix) but by varying the amount of mixing water, as per the following:

Gallons of water	28-day compressive strength. Lb. per sq. in.
[illegible]	2,700
[illegible]	2,400
[illegible]	1,950
[illegible]	1,470
[illegible]	830
[illegible]	200

The above table shows that the greatest strength of concrete is obtained when the least amount of water is used. Using 5¾ gal. of water for a one bag mix, a strength of 2700 lb. per square inch is obtained, whereas, when using 10 gal. of water, the strength diminishes to 830 lb. per square inch, or in other words, only two-fifths of the strength is obtained. It would seem ridiculous to the contractor to have the inspector tell him to leave out three-fifths of the cement as required by the specifications. Any good, reputable contractor would not lower the cement content, even if allowed by the inspector. But remember, that the ultimate strength is reduced by using too much water, just as much as by using too little cement. It has therefore been shown that the water is one of the principal ingredients of concrete, and should be measured with the same precision as the other materials. In particular is this true of concrete structures containing liquids. The greatest possible strength should be built into the tank, and one of the most important points to watch is the water content of the concrete.

Time of Mixing.—The time required for properly mixing concrete has always been a matter of much argument and discussion. Mixing concrete for one minute after all materials are in the drum of the mixer has always been considered ample time, and it is embodied in most specifications. Although it has been known that a longer period of mixing increases the strength of the concrete, it has always been thought that the progress of the work would be reduced too greatly to warrant the change. This condition does not affect tank construction, as the required amount of concrete is small, and it should therefore be recommended that a two-minute mix be used. This increases the strength by 10 per cent and also makes a denser concrete which is one of the most essential requirements of tank construction.

Too much emphasis cannot be given the importance of an adequate foundation for the concrete tanks. Some tanks have failed, and the cause has been traced directly to foundation deficiencies. The site should be inspected by an experienced engineer.

Monolithic construction is desired and recommended, although placing the concrete continuously is often impossible. The arrangements for placing the concrete should be carefully planned and each operation worked out in detail, so that when the placing of concrete is started, the work can be carried on continuously, thereby using the smallest number of construction joints.

Curing of Tank.—There are two methods successfully used for this purpose: (1) about 24 hours after all concrete has been placed, fill the tank with clean water for about one month; (2) coat the floor, interior walls and interior roof with silicate of soda. For this purpose use three or four coats of a 1:4 solution, 40° Be. sodium silicate, followed by a finish coat of 1:2 solution. This forms a glazed coat on the concrete, but does not last more than a year, and when its purpose of allowing the concrete to harden has been fulfilled its presence is no longer required. The concrete should be allowed to harden and age for one month before filling the tank with oil, as this increases the oil tightness of the tank.

Fig. 4—Construction View of 200,000-Gal. Fuel Oil Tank of Pullman Co., Pullman, Ill. L. J. Mensch, Contractor, Chicago, Ill.

The second curing process is usually used when water is not available for curing purposes. It is not a process of oil proofing for light oils.

The vital requirements for oil tank concrete are plasticity (for placing), and density (for oil-proofing). Concrete mixed in the proportion of $1:1\frac{1}{2}:3$ has these qualities, if the materials are well graded, the water content is correct, the proper mixing time adhered to, and a standard brand of Portland cement used.

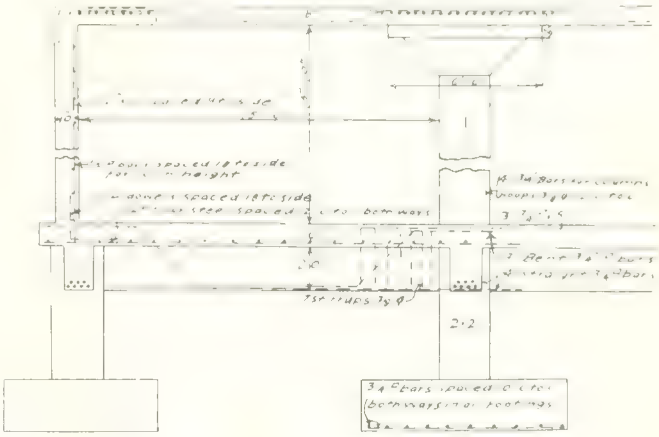

Fig. 3—Section Through Tank.

Oil-Proofing.—Concrete oil tanks have been constructed to contain oils of all gravities. It has been found necessary to oil-proof the concrete for the lighter oils. There are a great many satisfactory oil-proofing materials on the market. The quality of the material is, of course, important, but the workmanship and the methods used in applying the oil-proofing should be emphasized as being also of utmost importance. A great many of the oil-proofing materials are applied to the inside surface as a plaster coat. This work should be placed in the hands of the most expert water-proofing or plastering contractors. Many such reliable contractors are willing to guarantee and furnish a bond for their work. It is advisable to secure the services of a reputable firm or individual who is willing to make this guarantee.

Concrete tanks can be placed underground, partially or entirely above ground. When conditions are favorable, the underground tank should always be given first choice. The advantages of an underground tank are: that the temperature stresses of the tank are reduced to a minimum, the oil is maintained at a more uniform temperature than that of a tank partially or entirely above ground; the available ground area can be utilized for storage, transportation or building purposes.

Maintenance and Painting of Highway Bridges*

BY [illegible]

[illegible] repair [illegible] of the structure. Every [illegible] should be inspected [illegible] report made upon [illegible] should be made [illegible] small culverts should be inspected after every hard rain. By such a system [illegible] The cost of [illegible] with the structure be allowed to suffer from the lack of repairs.

Classification of Structures According to Structural Conditions.—[illegible] with the funds you may have available were I county road engineer in your county, and will try to suggest something helpful which may [illegible] be done if existing [illegible] conditions for traffic.

First. A complete inspection would be made as heretofore suggested and a complete report made of every existing structure within the county.

[illegible] The structures would then be subdivided into [illegible] (A) Structures [illegible] no repair or maintenance, (B) structures which must be rebuilt immediately, (C) structures which may be repaired or strengthened.

Third. The classes noted under (B) and (C) would again be subdivided, the class noted under (B) under three subheads as follows:

1. Structures which must be permanently renewed both the substructures and superstructures.
2. Structures in which the substructure only shall be renewed permanently and a temporary superstructure built thereon.
3. Structures in which the substructures are serviceable and require a permanent superstructure.

The bridges noted under (C) would be subdivided as follows:

1. Bridges requiring strengthening to trusses and floor systems.
2. Bridges requiring no strengthening but new floors.
3. Bridges requiring only painting.
4. Bridges requiring partial painting and repairs to floor.
5. Bridges requiring complete repainting and new floors.
6. Bridges requiring repairs to the substructure.

What would be the value of such a complex system of dividing and subdividing? There are many things it would show quickly. First, it would give a complete list of structures in your county with a classification which would allow the only correct distribution of the bridge fund. Second, it would show your court what was necessary on every bridge in the county during the coming year. Third, it would quickly afford a basis for estimating the money necessary for this maintenance and construction during the year and would be in such a form that it would appeal to every business man in the county because he would know you had investigated conditions. Fourth, it would emphasize the want of funds for this work. Fifth, it would outline this work for your men in advance for the year in every district and eliminate bringing the forces back and forth as these conditions were discovered or reported.

Having completed the report and an estimate of the cost of the work, it should be published in every newspaper within the county with a statement of the funds available and your policy for expending such funds in each district. Everyone would then see that the money had been allotted where needed. This is the only reason for a common pool of the county's funds in the county treasury, and the only equitable [illegible] raised by taxation.

Strengthening and Repairing Old Bridges.—Only class (C) structures will be discussed under maintenance. These are bridges which are to be strengthened, painted, refloored, or upon which work is required on the substructure. This work through necessity must be handled both by force account and by contract and it is well that we consider the most [illegible] work, namely, strengthening old bridges, [illegible]

The [illegible] trusses if too light for modern traffic do not offer [illegible] for strengthening at an economical cost. These trusses should be temporarily repaired and their floor systems brought up to the maximum capacities of the trusses. These bridges should be posted with signs warning the traveling public against overloading. The maximum allowable load should be clearly stated on the sign. It is possible that the floor systems can be increased by increasing the number of the floor beams and stringers, or else by increasing the size of floor beams and stringers. This can be economically done at a time when the floor has been removed for stringer repair or reflooring.

Many of the light steel truss bridges can be strengthened by changing the sizes of floor beams and increasing the number of stringers so that they may be made to carry safely double or perhaps three times the present wagon or truck loading. It may be necessary to make changes in connections and in certain web members to increase the capacity, but it can be done far cheaper than rebuilding in many cases. It is far cheaper to spend a few dollars in strengthening than to allow structures to be daily overloaded and their cost of maintenance to soar. There is a certain bridge I have in mind in which it is impossible to keep the floor nailed down in place due to the fact that the stringers and floor beams deflect so great under the heavy loads that they pull the nails.

There is a suggestion too with regard to strengthening bridges which may be accomplished with little additional expenditure. It is more important to be able to get your loads over a structure than it is to save time getting them over. It is possible in some cases to reduce both the dead load on a structure and to confine the moving load to the center of the bridge and thus carry over with safety greater loads. This can be accomplished by reducing the width of travel way of the bridge. The proper fences and guard rails must be installed to prevent accident or traffic from using the remainder of the structure.

Bridge Floors.—The day when bridge floors 2½ in. to 3 in. thickness can be economically used for modern traffic has passed. For heavy traffic the maximum span for 4-in. flooring should be about 27 in. This span can be somewhat increased for loads of 10 tons or less, or 3-in. floor used when the spacing of stringers do not exceed 24 in. Investigation of your bridge floors will show that few of them remain long enough for decay to destroy, but instead traffic wears them out. In replacing wooden floors, if the span is not strong enough and cannot be economically strengthened to carry a better type of floor, it is to be recommended that a 2-in. x 4-in. wooden floor be used, the lumber being laid on edge and all contact surfaces thoroughly swabbed with hot tar and cambered to shed water. This type of floor has been extensively employed on new structures and is giving complete satisfaction. I have just recently had occasion to inspect such a floor which had been down for a period of nearly 6 years and it showed no signs of decay or wear, yet it was subjected daily to a large volume of heavy traffic, both horse and motor drawn. The cost of this type of floor is about 50 ct. per square foot of floor surface. In laying this type of floor on old truss bridges whose stringers in the end panels merely rest on the concrete or masonry, it will be necessary to anchor at least the outside stringers to the masonry or else the floor will lift these stringers. About 1 bbl. of tar is required for every 30 ft. of length if the bridge has a 16-ft. roadway.

Painting.—Where the paint shows signs of deadness or rust has begun on the steel, these portions at least of a steel bridge should be thoroughly cleaned and repainted with red lead paint. It is not always necessary to repaint a bridge throughout and it is a poor policy to allow a portion of the structure to rust because the whole does not need repainting. This protection of your steel where needed may save repainting the entire structure for several years.

When a bridge is to be repainted, the steel must be thoroughly cleaned of rust, dirt, grease and dead paint. Too much emphasis cannot be laid upon the necessity of a thorough cleaning. A span may be cleaned by scraping, brushing with a wire brush, burning off the dead paint with a torch and then scraping or by a sand blast. The sand blast is the most efficient method of cleaning.

When it is necessary to repaint a bridge entirely and thoroughly clean it; red lead next to the metal itself is recommended. The red lead, if in paste form, should be mixed with boiled linseed oil in the field, about 18 lb. of red lead to 1 gal. of oil. After this coat of paint has thoroughly dried an additional coat of paint should be applied. For the additional coats of paint, some light colored paint is recommended because it betrays the presence of rust, harmonizes with the substructure and makes highway bridges readily visible at night. This paint should be mixed in about the same proportion by weight to the gallon of oil if mixed in the field as specified above for red lead. The cost of the paint itself is comparatively small to the cost of labor applying it and to the cost of cleaning the structure. Only the very best paints should be used.

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*[illegible]

Estimating Amount of Paint Required.—Knowing the weight, or by estimating the weight of a structure, we may approximate the amount of paint required. The old rule, namely, ½ gal. of mixed paint for the first coat and ⅜ gal. for the second and third coats per ton of steel give fair approximations. The weight of light steel bridges may be calculated approximately from the following formula by Kunz:

$$W = (0.12\,L + 12)\,(1.6 - 0.03B)\,BL.$$

W = weight of steel in pounds.

L = length of span in feet.

B = width of roadway in feet.

The estimated weights of the bridges built under the state are listed on the plans.

Cost of Painting.—The cost of applying the paint will vary due to different prices paid the labor and the same is true with regard to cleaning. This cost may be approximated by assuming a painter to cover 600 sq. ft. of surface per day. Applied to gallons of paint it means that a painter will apply about 1½ gal. of paint in an 8-hour day or if applied to tons of steel, one painter should cover about three tons per day. This appropriation will be found to agree fairly close to the actual cost if much scaffolding is to be done. The cost of cleaning will vary still more. It may be estimated if the steel is in bad condition that it will require one man one day to clean a ½ ton of steel, while if there are places which may be skipped, one may clean a ton within the same period of time. With the data expressed in hours, it can at once be referred to any scale of wages.

Paint to be effective must be elastic, must retard and prevent as far as possible rust; it must be a non-conductor of electricity and must be insoluble in water or else it will break down and disintegrate. Moisture cannot be excluded between the steel and paint, if paint is applied during wet or freezing weather. The second coat of paint must never be put on until the first coat has thoroughly dried.

Readjustment Work of Government Departments.—In an address at the conference of Mayors and Governors, March 3, 4 and 5, at Washington, D. C., Mr. Rodger W. Babson, Director, Division of Statistics and Education of the U. S. Department of Labor, outlined as follows the readjustment work of the various Federal departments:

Interior: Secretary Lane is seeking to utilize arid, swamp and cut-over lands; Dr. Claxton is seeking to interest the nation in spending $500,000,000 for new schools. War and Navy: Liquidation Commission appointed to dispose of military stores and facilities in the hands of our over-seas forces. Sales agent of the War Department is disposing of unused materials in a way to protect both industry and labor. Commerce: Secretary Redfield has taken the lead in a plan to stabilize prices of raw materials through the purchasing power of the Government, thus creating a firm, or rising market, favorable to business activity. Treasury: Secured from Congress authority to pay the informal contracts of the War Department. This department is also on the verge of starting construction of several million dollars' worth of buildings, held up by the war. Agriculture: Makes a continuing offer to the states for building highways on a fifty-fifty basis—about $275,000,000 now available. Labor: Making strenuous efforts to revive public and private building and construction development of all kinds, a special division having been created, under charge of Mr. Franklin T. Miller. It collects data relative to plans, cost of building material, where and how loans may be obtained, etc., all placed at the disposal of states, municipalities, corporations and private individuals, with a view to stimulating public and private construction of schools and other public buildings, residences, including wage earners' homes, sewers, water works and other municipal improvements.

Methods of Depositing Concrete Under Water

In a report submitted last week at the annual convention of the American Railway Engineering Association a subcommittee of the Committee on Masonry presented the following data as representing in its opinion the best practices to be followed in depositing concrete under water:

Of the methods used, the following seem to give the best results:

The concrete is lowered in large buckets having a hinged bottom which sets sufficiently far above the lower edge of the bucket so that it may open freely downward when the bucket reaches the surface upon which the concrete is to be deposited. The top of the bucket is left open, and care is taken to see that the bucket is completely filled before lowering. Efforts made to use a closed top bucket have not been successful, due to the disturbance of the deposited concrete by inrush of water as the bucket is withdrawn.

The concrete may be passed through a vertical tube or tremie reaching down to the surface upon which the concrete is to be deposited. In this case the tube should be kept filled with concrete at all times, and the flow should be as nearly continuous as practicable.

Jute or cloth bags, from two-thirds to three-fourths filled, have been used successfully. These are placed in a header and stretcher system so that the whole mass is interlocked.

Where it is difficult to construct a cofferdam or monolithic work is not required, premolded concrete blocks of large dimensions have been used successfully.

A concrete depositing bag made of canvas or other suitable material is a variation of the bucket system. This is filled and the mouth of the bag closed by one turn of a line so looped that a pull on the line will release it. The bag is lowered mouth down to the surface upon which the concrete is to be deposited, and a sharp pull on the line opens the bag and permits the concrete to be deposited. This method does not have the disadvantage of the closed top bucket, since the bag will collapse as the concrete flows out.

There are a number of other methods that have been used, such as depositing directly through the water; depositing a portion of the concrete by one of the above methods in the corner of the form and the balance progressively from wheelbarrows or buckets on the sloping surface, thus gradually filling the form; allowing the concrete to partially set in air and then depositing it in a plastic condition; depositing the concrete dry without the use of water; attempting to grout a foundation composed of riprap or coarse gravel by means of pipes sunk at intervals into the foundation. Although occasionally fair results have been obtained, all of these methods are dangerous, as they almost uniformly result in segregation of the materials or the washing out of the cement.

Depositing With Drop Bottom Buckets.—The drop bottom bucket should be so arranged as not to discharge the load until the bucket reaches the surface upon which the concrete is to be deposited. In lowering the bucket, care should be taken that unnecessary wash is not produced. This may be avoided by slowing up the operation when the bucket is passing through the water. The bucket, when the load is discharged, should be withdrawn slowly until clear of the concrete. In depositing concrete under water by this method it is imperative that the work be continuous and sufficiently rapid to insure bonding of the successive layers. By this means the laitance formed can be brought to the finished surface and later removed after the concrete has hardened. There are a number of other types of buckets, such as the tipping bucket or bottom dumping bucket. The use of all these should be avoided, as they tend to stir up the material and wash out the cement.

Depositing Through Tremie or Vertical Tubes.—This device should be about 14 in. or 16 in. in diameter, made up in sections so that the length may be adjusted to the depth of the water. The joints should be made flanged and the tube put together with gaskets, in order to avoid leakage of the water into the tube. The top should be flared, in order to receive the concrete properly. The tube should be suspended in such manner that it may be moved laterally as required. The upper end is placed near the level of the working platform, while its lower end rests on the surface upon which the concrete is to be deposited. When the operation starts the tube should be filled in such manner that the concrete is not per-

[illegible] This is accomplished [illegible] filled with concrete. In both these methods undesirable material is introduced into the concrete, but if the area to [illegible] be kept [illegible] of this method [illegible] charge is not lost in moving it about the bottom. In case it is lost, the tube should again be filled as at first. One of the disadvantages [illegible] it is almost impossible to avoid losing the charge occasionally. This will depend very largely on the quality of the supervision exercised over the work. Another disadvantage of this method is that the area over which it can be used is limited, and if [illegible] a large area a number of tubes should be used. With this method, as with all others, it is desirable that the concrete be deposited continuously from the time the work is started until it is brought above the water level or to the finished surface, which can later be cleaned in the air after the concrete has hardened.

Considerable difference of opinion exists among engineers as to whether the concrete to be deposited by this method should be made wet or dry. In the first case the concrete is made quite wet and the bottom of the tremie submerged several feet below the surface of the concrete as deposited. The material is allowed to flow out of the tube and seek its own level. In depositing the concrete dry, just sufficient water is used to make it plastic and the concrete is distributed by moving the foot of the tremie over the surface. Good results apparently have been obtained from each of these methods, but the opinion of the committee is that the dry method is preferable. If the concrete is deposited wet considerable difficulty is encountered in keeping the tremie full and more or less segregation of the materials is bound to occur. It is extremely difficult to move the tube where sufficiently submerged in the concrete to permit the wet concrete being used.

Bagging Method.—While the bagging method insures good concrete and will prevent the formation of laitance, it is open to the objection that a monolithic foundation is not secured. Where, however, the walls of the foundation formed by the bags will not be exposed to scour, the committee is of the opinion that the method will give satisfactory results. This method can be used to advantage in sealing the foundations of cofferdams where it is impracticable to prevent inflow of water through crevices in the bottom. In using this method it must be borne in mind that satisfactory results cannot be obtained unless the bags are carefully placed by hand, and this makes the service of a diver necessary except where placed in very shallow water.

Premolded Concrete Blocks.—Premolded concrete blocks can be used to advantage on a prepared foundation in large structures such as breakwaters, bulkheads, lighthouse foundations, seawalls—any heavy construction where the units can be large enough not to require bonding. The blocks are usually molded in the air in units weighing from 15 to 20 tons, and are deposited in place by the use of derricks.

Materials and Mixing.—Concrete to be deposited in water should be of a richer mixture than when deposited in air, and a leaner mixture than 1-2-4 should not be used. It is the opinion of the committee that only so much water should be used as will make the concrete of a plastic consistency. Very dry concrete is as undesirable for this purpose as wet concrete. It is the opinion of the committee that washed gravel of somewhat smaller size than used in the open air concrete will give the best results. This is particularly true where the tremie method is used. The sand should be free from loam and other material, and it is preferable that washed sand be used where possible to obtain it. The aggregate should be capable of producing dense concrete, and it is recommended that tests be made of the materials available to determine the best aggregate for this purpose.

Precautions.—In depositing concrete under water it is imperative that the water be still and that the concrete shall not be exposed to current until it is fully set. This requires that a cofferdam be constructed in such manner as to insure quiet water within the cofferdam. One of the essentials of depositing concrete by any of the above methods is that the concrete be disturbed as little as practicable during the depositing, thus avoiding the formation of laitance. It is impracticable in depositing concrete in water by any method to entirely avoid laitance, and it is therefore necessary on completing a section of concrete to see that the laitance is entirely removed after the concrete has thoroughly set and before the work is resumed. For this reason it is the opinion of the committee that when a job is started the concrete should be deposited continuously until the finished surface is reached or the concrete brought above the water level so that the laitance may be removed in the air, as it is difficult, if not impracticable, to entirely remove it under water. The formation of horizontal construction joints under water should be avoided.

The ordinary precautions used in depositing concrete in the air are not sufficient when depositing concrete in water, and additional care must be observed in the latter case to prevent segregation of the materials, the formation of laitance, and to insure proper setting of the mass. Because of the fact that cold retards setting, the concrete should not be deposited in water the temperature of which is low enough to cause serious retardation. Concrete should be thoroughly mixed before it is deposited in water and, therefore, hand mixing should never be permitted, but a batch mixer used.

How to Distinguish Douglas Fir from Sitka Spruce Lumber

Douglas fir and Sitka spruce are frequently put to the same uses, particularly in the building of airplanes, but they do not have exactly the same properties. This fact makes it desirable to have a ready means of identifying the lumber of these species. The use of the following key prepared by the Forest Products Laboratory should help in telling the two woods apart:

General Characteristics.—Douglas fir is darker in color than Sitka spruce, and has more pronounced annual rings. Of the two, Douglas fir is decidedly the more resinous.

Color.—The color of Douglas fir, as seen on a freshly cut longitudinal surface, is orange-red to red; that of Sitka spruce is pale pinkish brown. The color varies in both species, however, so that the darker spruce is about the same as the lighter fir. There is a marked contrast in color between the heartwood and sapwood in Douglas fir; in Sitka spruce the difference is less pronounced, both being quite light in color. Douglas fir is not so lustrous as Sitka spruce which has a very noticeable "silky sheen."

Annual Rings.—In both species each annual ring is made up of a light, soft band or layer, known as springwood, and a dark, dense band known as summerwood, the summerwood being on the side toward the bark. In Douglas fir the bands of summerwood are usually very conspicuous and clearly defined from the springwood, but in Sitka spruce the springwood merges gradually into summerwood.

Resin.—Douglas fir is more resinous than spruce and often shows abundant exudations on cuts made before the lumber was seasoned. Such exudations of resin are scarce in spruce.

Tangential Surface.—Tangentially split surfaces (surfaces made by splitting along the rings) of Sitka spruce usually have numerous slight indentations giving it a "pocked" or dimpled appearance never found in Douglas fir. This characteristic is more pronounced in spruce with narrow annual rings and may be missing entirely in wide-ringed material, especially that near the center of the tree. Therefore, this observation should be made where the rings are narrowest. Occasionally the eastern spruces also show this uneven tangential surface to a slight extent. Some trees of western yellow pine also develop a "pocked" appearance of the wood, but the pine can be distinguished by the larger and more numerous resin ducts.

Bark.—Pieces of bark, if found on the lumber, afford a reliable means of distinguishing between Douglas fir and Sitka spruce. Douglas fir has a thick bark with characteristic whitish layers. Spruce has a thin bark without whitish lyers.

Cell Walls.—With the aid of a compound microscope, Douglas fir can easily be distinguished from Sitka spruce. Douglas fir has spiral thickenings on the inside of the cells similar to the thread in a nut, but the cell walls of spruce are without such spirals.

Effect of Quantity of Mixing Water and Curing Conditions on the Strength and Wear of Concrete

The necessity for careful restriction in the quantity of mixing water used in concrete, and the importance of proper curing conditions during the period of setting and hardening are not generally appreciated by engineers and contractors. In view of these facts the recent experimental studies of Prof. Duff A. Abrams of the Lewis Institute, Chicago, on the effect of water content and curing conditions on the compression strength and wearing resistance of concrete are of particular interest. The tests were made as a part of the experimental studies of the properties of cement and concrete materials, and were carried out at the Structural Materials Research Laboratory of Lewis Institute, through the co-operation of the Institute and the Portland Cement Association. The results of the studies were summarized by Prof. Abrams in a report presented last week at the annual convention of the American Railway Engineering Association. The matter following is taken from this report.

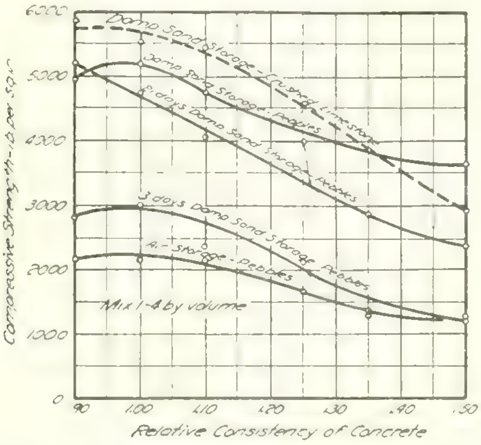

Fig. 1.—Effect of Quantity of Mixing Water on Strength of Concrete.

Compression tests of 6x12-in. cylinders at age of 4 months. Each value is average of 4 tests made on two different days. Same data as in Fig. 3.

The series comprised compression tests of 120 6x12-in. cylinders and wear tests on 300 blocks, 8 in. square and 5 in. in thickness. A 1-4 mix was used throughout, that is, 1 volume cement and 4 volumes mixed aggregate. This mix is about the same as the 1-1½-3 or 1-2-3 mixes generally used for concrete which is to withstand high stresses or to form the wearing surface of pavements. Most of the tests were made on sand and pebble aggregates. One group was repeated with crushed limestone as coarse aggregate.

Concrete of six different consistencies was used, each being stored under four different conditions:

(1) Damp sand 4 months, tested damp.

(2) Damp sand 21 days, air 99 days.

(3) Damp sand 3 days, air 117 days.

(4) Air of laboratory for entire curing period of 4 months.

Parallel tests were made throughout on compression and wear. All tests were made at the age of 4 months.

The term "consistency" refers to the plasticity of the concrete; that is, the relative and not the actual quantity of mixing water. It has been found convenient to express the quantity of water used in the concrete in terms of volume of cement. This so-called water-ratio has been shown to be the best criterion of the strength of the concrete.

The consistency taken as "normal" (relative consistency =1.00) is of such a plasticity that a 6x12-in. cylinder of 1-4 concrete will "slump" ½ to 1 in. upon removal of the metal form by a steady, upward pull immediately after molding the specimen. Concrete of relative consistency of 1.10 will show a slump of 5 to 6 in.; 1.25, a slump of 8 to 9 inches.

Effect of Quantity of Mixing Water on the Strength of Concrete.—Figure 1 gives the results of the tests on the effect of quantity of mixing water on the compressive strength of concrete. A separate curve has been drawn for each curing condition. An average curve from these tests will be found in Fig. 6. The remarkable influence of the quantity of mixing water on the strength, other factors being the same, is clearly shown by these curves. It will be remembered that the consistency called 1.00 (normal consistency) is such that a 1-4 mix gives a slump of ½ to 1 in. when the form is slipped off the freshly molded cylinder. A consistency of .90 contains 90 per cent of the amount of water required for normal consistency; a consistency of 1.50 contains 1½ times the quantity of water used in the normal consistency concrete, etc. The normal consistency concrete may be characterized as plastic; the .90 is somewhat dry; the 1.50 quite wet, but contains much less water than the "sloppy" mixes frequently seen in reinforced concrete work.

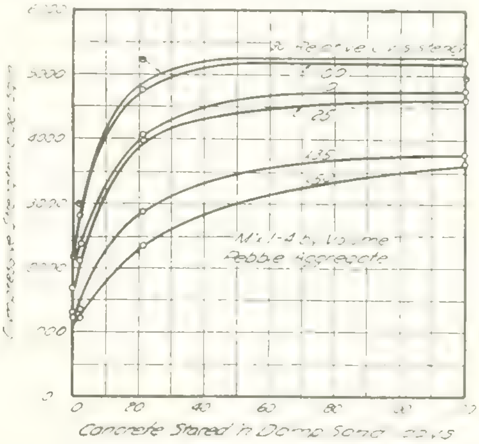

Fig. 3.—Effect of Curing Conditions on Compressive Strength of Concrete.

Compression tests of 6x12-in. cylinders at age of 4 months. Each value is the average of 4 tests made on two different days. Same data as in Fig. 2.

It will be noted that there is a rapid falling-off in strength as the water content is increased from normal consistency. With a consistency of 1.25 the strength is reduced to about

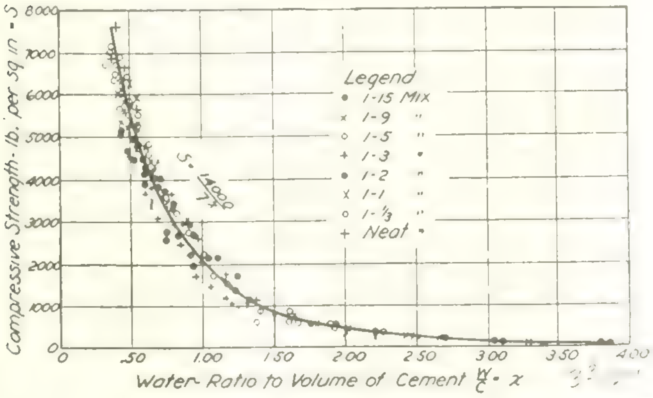

Fig. 2.—Effect of Quantity of Mixing Water on Strength of Concrete.

Compression tests of 6x12-in. cylinders at age of 28 days. Each value is the average from five tests.

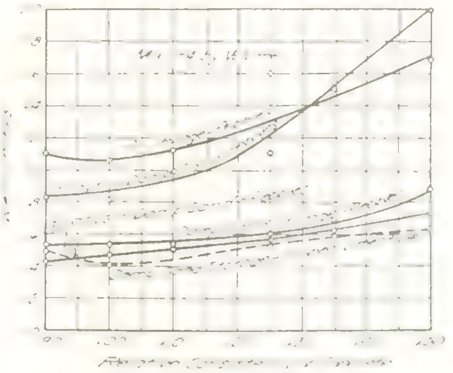

Fig. 4.—Effect of Quantity of Water on Wear of Concrete.

Wear tests of 8x5-in. blocks at age of 4 months. Each value is the average of 4 blocks made on two different days. Same data as in Fig. 5.

[illegible] per cent of the [illegible] consistency of 1.25 [illegible] strength is [illegible] that which may be obtained with the same [illegible] the strength would [illegible].

[illegible] In concrete road [illegible] must be mixed [illegible]. In other words [illegible]. This consistency will give a slump of [illegible]. [illegible] consistency corresponding closely to maximum strength. In reinforced concrete work [illegible] mixes wetter than 1.25 consistency, corresponding to a slump of 8 to 9 in.

The average curves in Fig. 6 have been platted in terms of the water ratio instead of the relative consistencies, although [illegible] consistencies are also shown. The water ratio is the ratio by volume of water to cement in the batch.

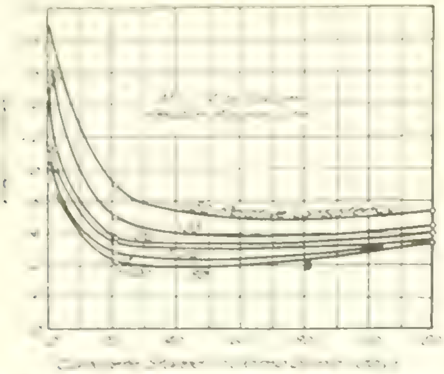

Fig. 5.—Effect of Curing Conditions on Wear of Concrete.

[illegible]

Further Discussion of Effect of Quantity of Mixing Water on the Strength of Concrete. Many series of tests made in this laboratory have fully established the fundamental importance of the quantity of mixing water on the strength of concrete.

Figure 2 gives the average values from a series of tests of this kind in which the compressive strength is platted against the water-ratio of the concrete. In this series the mixes ranged from 1-15 up to neat cement. The consistencies were varied over a wide range. The size of the aggregate ranged from a very fine sand to a coarse concrete aggregate, for all combinations of mix and consistency.

In the figure distinguishing marks were used for each mix, but no distinction was made between aggregates of different sizes or concretes of different consistencies. When the compressive strength is platted against the water content in this way a smooth curve is obtained, due to the overlapping of the points for different mixes, consistencies, etc. Values from the dry concretes have been omitted from the diagram; if these were used we should obtain a series of curves dropping downward to the left from the curve shown. It is seen at once that the size and grading of the aggregate and the quantity of cement are no longer of any importance except in so far as these factors influence the quantity of mixing water required to produce a workable concrete. This gives an entirely new conception of the function of the constituent materials entering into a concrete mixture.

The equation of the curve in Fig. 2 is of the form

$$S = \frac{A}{B^x}$$

where S is the compressive strength of the concrete and x is the ratio of the volume of water to volume of cement in the batch (water-ratio). A and B constants whose values depend on the quality of the cement used and on other conditions of the test.

The values of the constants in these tests are shown on the diagram. This equation expresses the law of the strength of concrete so far as variations in the proportions of materials are concerned. It is seen that for given concrete materials [illegible] the water ratio. Equations which have been proposed for this purpose in the past contains terms which take into account such factors as quantity of cement, proportions of fine and coarse aggregate, voids in aggregate, etc., but they have uniformly omitted the only item which is of any importance; that is, the water. The relation given above holds so long as the concrete is not too dry for maximum strength, and the aggregate not too coarse for a given quantity of cement; in other words, so long as we have a workable concrete.

The strength of the concrete responds to changes in water, regardless of the reason for these changes. The water-ratio may be changed, due to any of the following causes:

(1) Change in mix (cement content).
(2) Change in size or grading of aggregate.
(3) Change in relative consistency.
(4) Any combination of (1) to (3).

In certain instances a 1-9 mix is as strong as a 1-2 mix, depending only on water content. It should not be concluded that these tests indicate that lean mixes can be substituted for richer ones without limit. We are always limited by the necessity of using sufficient water to secure a workable mix. So in the case of the grading of aggregates. The workability of the mix will in all cases dictate the minimum quantity of water that can be used. The importance of the workability factor in concrete is therefore brought out in its true relation.

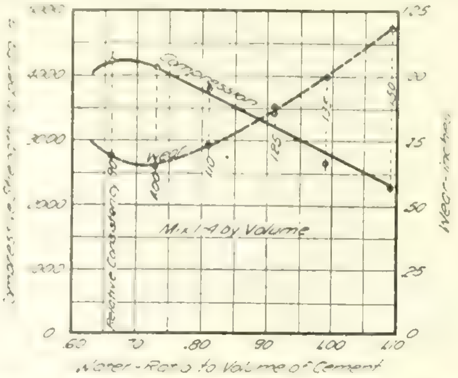

Fig. 6.—Effect of Quantity of Water on Strength and Wear of Concrete.

([illegible] curves from Figs. 2 and 4. The quantity of mixing water is expressed as a ratio to the volume of cement in the batch. Each value of compression is the average of 20 tests (from curing condition [illegible]). Each value for wear is the average of 50 tests (from curing condition [illegible]).)

The problem of designing concrete mixes resolves itself into this:

To produce a workable concrete with a given water-ratio using a minimum of cement; or the converse, to produce a workable concrete which has the lowest water-ratio for a given quantity of cement. The methods of securing the best grading of aggregate and the use of the driest practicable concrete are seen to be only devices for accomplishing the above mentioned results.

The influence of the water-ratio of concrete on its strength will be shown by the following considerations: One pint more water than necessary to produce a plastic concrete in a 1-4 mix reduces the strength to the same extent as if we should omit 2 to 3 lb. of cement from a one-bag batch.

The studies give an entirely new conception of the function performed by the various constituent materials. The use of a coarse, well-graded aggregate results in no gain in strength unless we take advantage of the fact that the amount of water necessary to produce a plastic mix can thus be reduced. In a similar way we may say that the use of more cement in a batch does not produce any beneficial effect, except from the fact that a plastic, workable mix can be produced with relatively less water.

The reason a rich mixture gives a higher strength than a lean one is not that more cement is used, but because the concrete can be mixed (and usually is mixed) with a lower water-ratio in the case of the richer mixtures than for the lean ones. If advantage is not taken of the fact that in a rich mix relatively less water can be used, no benefit will be gained as compared with a leaner mix. In all this discussion the quantity of water is compared with the quantity of cement in the batch (cubic feet of water to one sack of cement) and not to the weight of dry materials or of the concrete, as is generally done.

Effect of Quantity of Mixing Water on the Wear of Concrete.—Figures 4 and 6 give the results of tests to determine the effect of quantity of mixing water on the wear of concrete. It will be noted that the depth of wear is expressed in inches. The wear-water-ratio relation is just opposite to that found in the strength tests; in other words, a high strength is accompanied by low wear, and vice versa. If the wear curve in Fig. 6 were inverted we should have almost a duplicate of the strength curve. In general, the lowest wear is found at about the same water-ratio as the highest strength. The average curves (Fig. 6) show that maximum strength and minimum wear come at a consistency of about .95, or a water-ratio of about .70. It should be pointed out that for other mixes the best results would probably be found at about the same relative consistency, but at a different water-ratio. For a given consistency the water-ratio is higher for lean mixes and lower for rich mixes.

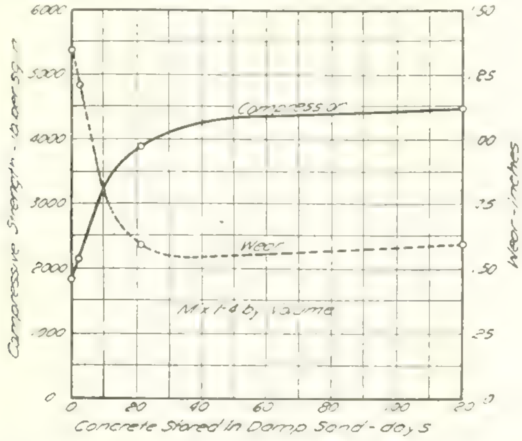

Fig. 7.—Effect of Curing Condition on the Strength and Wear of Concrete.

Average curves from Figs. 3 and 5. Each value for compression is the average of 24 tests (four each for six consistencies). Each value for wear is the average of 60 blocks (10 each for six consistencies). The upward trend of the wear curve results from the abnormal wear of the 4-month sand-stored blocks on account of being tested in damp condition.

Water Required for Concrete Mixes.—Since the quantity of mixing water exerts such an important influence on the strength and other properties of concrete, it will be of interest to examine the factors which influence the amount of water required for satisfactory results. The function of water in concrete is twofold:

(1) To supply the water necessary for hydration of the cement.

(2) To produce a plastic mixture.

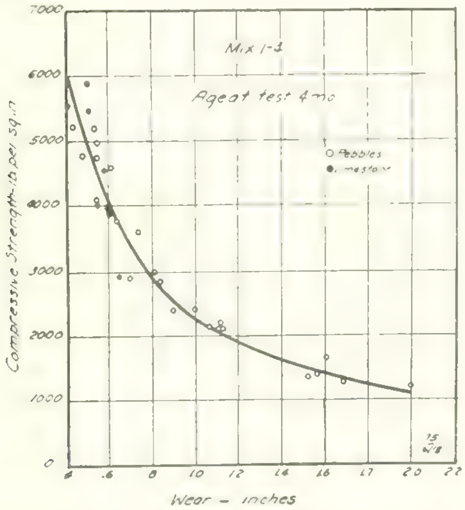

Fig. 8.—Relation Between Compressive Strength and Wear of Concrete.

Compression tests of 6x12-in. cylinders and wear tests of 8x8x5-in. blocks at age of 4 months. Each value is based on averages of four compression tests and 10 wear tests. All consistencies.

While the exact quantity of water required under (1) has not been determined except in certain instances, it is generally agreed that the quantity used in concrete is greatly in excess of that necessary for hydration of the cement. The bulk of the water in concrete is used in order to produce a plastic or workable mix. The exact quantity required for this purpose depends on the materials used, nature of the work, and methods of handling and finishing.

It is, in general, impracticable to state in definite quantities the amount of water which should be used, since this depends on many different factors, such as the following:

(1) The relative consistency which must be used, which is dictated by the nature of the work.

(2) The normal consistency of the cement.

(3) The quantity of cement.

(4) The size and grading of the aggregate.

(5) The absorption of the aggregate.

(6) The moisture content of the aggregate.

(7) Admixtures which may be used.

The quantity of water which affects the water-ratio as given in Fig. 6 is only such a part of the whole as affects the cement. In other words, the water which is absorbed by the aggregate is not considered as influencing the water-ratio. This makes it plain that the absorption of the aggregate must be taken into account if concretes from widely different aggregates are being compared. Many serious errors have been made in drawing conclusions from tests, due to failure to take into account the influence of absorption, grading of aggregates, etc., on the water content of the concrete.

In general, it is impracticable to determine in advance the exact quantity of water required for concrete mixes, largely due to two causes: (1) Inability to determine in advance the lowest relative consistency which may be used and still produce a workable concrete; (2) varying moisture content of aggregates.

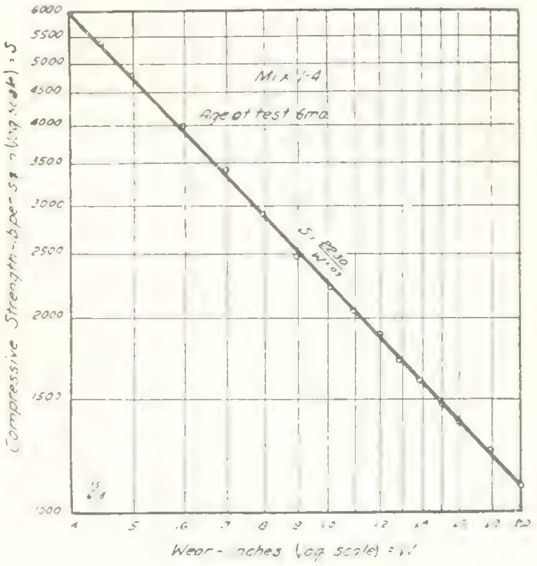

Fig. 9.—Relation Between Compressive Strength and Wear of Concrete.

Same data as in Fig. 8 except curve plotted on logarithmic scales. The points shown are taken from the curve in Fig. 8.

Table I may be of interest in indicating the approximate quantities of water necessary for certain mixes. It is assumed that a well-graded aggregate up to 1½ in. in size will be used. Only under the most favorable conditions can the minimum values be used; in general, the maximum values need not be exceeded.

TABLE I.

Mix.		Approximate Mixes as Usually Expressed.			[illegible]	
	Volume of Aggregate		Aggregate.			
Cement.	After Mixing.	Cement.	Fine.	Coarse.	Minimum.	Maximum
1	5	1	2	4	[illegible]	[illegible]
1	4½	1	2	3	[illegible]	[illegible]
1	4	1	1½	3	[illegible]	[illegible]
1	3	1	1½	2½	[illegible]	[illegible]

Without regard to the actual quantity of mixing water, the following rule is a safe one to follow:

"Use the smallest quantity of mixing water that will produce a workable mix."

The importance of methods of proportioning, mixing, handling, placing or finishing concrete which will enable the builder to reduce the water content to a minimum is at once apparent.

Effect of Curing Condition on the Strength of Concrete.—The effect of curing condition on the compressive strength [illegible] is given in Fig. 7. All [illegible] in [illegible] compared with. [illegible] The dryer [illegible] storage in a [illegible] the [illegible] its strength of the dryer [illegible] as compared with the specimens [illegible] for the entire period. It should be borne in mind that [illegible] favorable case used in the experiments the concrete was in the steel form for 1 day with only the top exposed, consequently the conditions were more favorable than those frequently found in summer weather or in arid regions where the concrete is exposed to rapid evaporation of the mixing water from the moment it is mixed.

The concrete stored for 4 months in damp sand and tested [illegible] which has been exposed to room atmosphere for the same period. Protecting the concrete from drying out for only 10 days (taking values from Figs. 3 and 7) gives an increase in strength of about 75 per cent for the dryer mixes.

Effect of Curing Condition on the Wear of Concrete.—The effect of curing conditions on the wear of concrete is no less striking than the effect on the strength.

It will be seen in Fig. 7 that the blocks stored for the entire period of 4 months in damp sand showed more wear in most instances than those which had been stored for 21 days in damp sand and the remainder of the time in air. This peculiar result is no doubt due to the fact that the concrete was tested in a damp condition, and does not indicate that the longer period in damp sand is injurious. The comparison would have been more nearly correct if the blocks had been allowed to dry out a few days before testing. These results do show that concrete in a wet or damp condition suffers more from wear than when dry. It is a matter of common experience that non-metallic materials, such as timber, terra cotta, concrete, stone, etc., which absorb water, show a lower strength in a wet condition than when dry. Additional tests will be required to show the exact effect of moisture content on strength and wear of concrete, other factors being the same.

It is not necessary to speculate on the probable effect of moisture in the concrete in order to secure valuable information from these tests. The dryer mixes show an increase in wear from .50 for concrete stored in damp sand for 21 days, to 1.10 in. for concrete in air for entire period; the tests indicate that 10 days in damp storage would give a wear of about 6.5 in. For the wetter mixes the wear after 21 days in damp sand is about .85 in.; for 10 days 1.15 in.; for air storage throughout probably 2 in. In the wetter consistencies the tests were not carried to completion on account of disintegration of certain blocks, which caused the entire ring to collapse.

Recapitulation of Effect of Consistency and Curing Condition.—In view of the important influence of consistency and curing conditions of concrete shown by these tests, it seems doubtful if there is any phase of concrete work which will pay such high dividends as a little care to see that proper consistency is used and desirable curing conditions are provided. In many instances the quality of the concrete could be vastly improved at trifling expense, but nothing is done because those in charge do not appreciate the importance of care in these directions. The writer is convinced that practically all of the faults from concrete floors follow from these two causes. 'Excessive wear and dusting are certain to result in a floor in which the concrete is never allowed to have the water necessary for hydration of the cement. It is notable that dusting never occurs on a concrete road, for the reason that it gradually gets the water necessary for hydration from rain or snow. However, due to low wearing resistance at early periods, resulting from premature drying, it may be badly worn before rain comes.

An excess of mixing water is a serious fault in concrete. If, in addition to too much water the concrete is allowed to dry out at once it is almost certain to be a failure if subjected to wear and will give very low strength. For the two wettest consistencies and the two most unfavorable curing conditions, the compressive strength of the pebble concrete was 1300 lb. per square inch; for the two most favorable curing conditions and the three dryest consistencies the average compressive strength was 4875 lb. per square inch—an increase of 275 per cent. In the case of the wear tests the corresponding values are 1.70 in. and .50 in.; an increase of 240 per cent. The comparison in the wear test is not as unfavorable as it should have been, since the poorer blocks broke up before the test was completed.

Proper curing of concrete is second only in importance to the control of water content. The rule stated above with reference to water content may now be extended to the following:

Use the smallest quantity of mixing water that will produce a workable concrete, then allow the concrete to have as much water as possible during the period of curing.

All concrete should be protected against premature drying for at least one week, and longer if practicable. This period should be extended to 10 days or two weeks in cool weather, or where the concrete is to be subjected to heavy traffic at an early age.

Covering with damp sand or earth, or wet burlap are excellent methods of curing. The practice of "ponding" is common in road construction. The writer wishes to offer a word of caution with reference to the use of wet sawdust for covering concrete floors. Sawdust may have most harmful results, on account of the organic acids present.

Compression tests of concrete made in other series show that the strength of concrete increases indefinitely, so long as it is not permitted to dry out.

Relation Between Strength and Wear of Concrete.—The relation between strength and wear of concrete in this series is shown in Fig. 8. All tests have been platted. Each value is based on the average of four compression tests and 10 wear tests. This diagram shows that a definite relation exists between strength and wear at least for the conditions of these tests; that is, for concrete of different consistencies and curing conditions. Further tests will be necessary to show whether or not this relation is entirely general for other aggregates, etc.

Figure 9 is the same curve platted to log. scale. The straight line in this diagram enables us to devise the equation:

$$S = \frac{2230}{W^{1.07}}$$

as showing the relation between the variables; where $S =$ compressive strength in pounds per square inch and $W =$ the depth of wear in inches.

Comparison of Pebble and Crushed Stone Aggregate.—Crushed limestone was used as coarse aggregate in one group of tests. In general the limestone concrete gave somewhat higher strength and lower wear than the gravel concrete using the same sand and the same water and cement. However, the tests do not cover a sufficient range to justify definite comparisons of the merits of the two types of aggregate. Both the aggregates used in this series were of high grade and gave good results in the tests.

Cost of Forms for Concrete Bridges and Culverts.—It has been found in bridge and culvert work in Kentucky that a fair approximation of the cost of forms for the different classes of reinforced concrete superstructures or culverts in state work may be estimated per cubic yard of concrete (if the forms are not to be used the second time) by allowing 100 ft. B.M. of lumber per cubic yard and four hours' time each for the carpenter and helper for the erection; and for the substructures of slabs or girder bridges, 2½ hours' carpenter's time and 2½ hours' helper's time for the plain concrete. These figures, stated Mr. Charles D. Snead, Bridge Engineer of the State Department of Public Roads, in an address at the recent Kentucky Road School, are based upon actual work done with the ordinary type of labor available in the state. Where the forms are used twice it has been found that it requires about one-half the time, estimated for buildings, to re-erect them.

Only 12½ Per Cent Capacity of Fabricating Shops Contracted for in February—The records of the Bridge Builders and Structural Society, as collected by its secretary, show that during the month of February, 1919, 12½ per cent of the entire capacity of the bridge and structural shops of the country was contracted for.

Methods, Economies and Standardization in Preparation of Plans for School Buildings*

By CLARENCE E. DOBBIN.

The term "plan production" may be objected to by some as resembling too closely the term "shop production" used almost exclusively by manufacturers; but the fact remains that there is a distinct problem of this kind in any architectural office with a volume of work such as we have in hand. It is a problem of sufficient importance to merit thoughtful, scientific treatment and if it handled without sacrifice either in architectural design, planning or construction there can be no valid objection to any appropriate term used to designate it.

In order to obtain uniform practice for all jobs in course of preparation at any one time, we have reduced to writing all instructions and decisions that go to make up our office practice. These, together with tabulations, small drawings showing typical arrangements of the various standard rooms, and other details that may be of assistance to draftsmen, are bound in loose-leaf form with subjects alphabetically arranged and make up what is termed our Office Manual. A copy of this is placed in the hands of each squad leader for ready reference.

Each new question that arises is investigated and considered with great care and when a satisfactory solution is reached the necessary instructions are placed in the manual. If later on a better solution is evolved, new instructions are issued to replace the earlier ones. The manual keeps everyone informed as to the latest decisions so that all effort may be directed towards the same objectives. The squad leaders are expected to see that their assistants follow these standards, or, if a variation seems advisable, to refer the matter to the chief for decision.

In this way only can the practice of the office be kept standard. In the absence of such a manual the office practice must be transmitted from one draftsman to another by word of mouth. This is the usual method and it is responsible for great loss of efficiency, because the same questions are asked and answered repeatedly, and the same problems solved again and again, with attendant discussions, delays and variations in practice. New men have no definite, accurate way of acquiring the office practice and often proceed along incorrect lines.

The planning of our new school buildings is accomplished through the co-operation of the four divisions into which the office is divided—General Drafting and Plumbing, Heating and Ventilation, Electrical and Furniture. Each of these divisions has its own head and all are under the immediate direction of the Architect in Chief, who also has jurisdiction over the inspection force connected with the construction and equipment of the buildings.

In our steel designing many of the factors are constant. The dead weight of our typical floor construction is always the same and the live loads for certain groups of rooms are alike. We have therefore developed tabulations of various kinds that enable the engineers to select the steel shapes much more quickly than by computation or by reference to a hand book. One such table gives the safe I-beams for different lengths and spans, assuming our typical dead load and a live load of 75 lb. There are other tables for live loads of 100 lb., 120 lb., etc. Having worked out a beam plan and fixed the lengths and spans of the beams, their sizes can be obtained from these tables with the least expenditure of time. Similar tables have been provided for many other structural members for which we have constant use: channel columns for our standard story height of 15 ft. 0 in., safe loads for struts made up of one, two and four angles in various positions, etc.

The volume of work is such that a number of jobs must be put forward at the same time. The work naturally segregates itself into subdivisions, such as general planning, designing, scale detailing, full-size detailing, structural-steel and other engineering, plumbing, specification writing and computing.

The first essential is a properly organized and balanced drafting force. The employes of this division are divided into appropriate squads, each of which is continuously engaged in one kind of work. While the personnel of the squads may change from time to time the leaders at least are comparatively permanent and become thoroughly familiar with the established methods in their particular branches of the work. The qualifications, inclinations and aptitude of each man are studied so that he may be placed where he will count for the most. This is a matter of great importance and careful attention to it has led to the discovery of special ability in some men, which when developed has produced surprisingly good results.

The next step is to standardize the details for features which occur repeatedly in different buildings; for example, a standard detail is made covering the entire construction of the ordinary double-hung window. This drawing is made on tracing cloth and once prepared can be used for any number of buildings without further drafting, by striking off the necessary number of blue prints. Similar standard details are made for pivoted windows, hollow metal windows, steel windows, steel doors, wood doors, kalamein doors, skylight construction, vault-light construction, interior trim, cabinets, wardrobes, lockers—in fact, for every possible feature of the building from column bases to the flagpole on the roof. These standard details do not entirely obviate the necessity for special details, but their number is thereby reduced to the minimum.

The advantages of these standards are threefold: First, the entire subject is very thoroughly studied when the standard is prepared and the detail is made to cover every phase of the construction, so as to furnish all the information required on that subject. Second, the draftsmen become familiar with the standards and are able to proceed with the plans much more expeditiously. Third, the contractors after becoming familiar with them, are able to systematize their methods of production and to reduce their estimates accordingly.

This division has at the present time about 100 standard details of this kind. A complete file of these is furnished to each squad leader and each is required to plan his work in conformity with them as far as practicable. This does not discourage suggestions on the part of assistants. These are always welcomed and the standards are revised whenever better methods are found. It does prevent waste of time in study of unauthorized variations of no practical value, undertaken often for no better reason than the desire to do the thing differently.

When conditions are such that a type building cannot be used, the general plans, framing plans and plumbing plans must all be specially made; but the standard details are applicable to these as well as to the type buildings, which minimizes the labor of detailing.

Where the drawings for one building are to be substantially like those for another building we take advantage of methods of process reproduction in order to reduce the amount of tracing. It is necessary to have a full set of tracings for each building, because additional prints may be needed at any time, either during the progress of building or after completion.

An earlier attempt to curtail drafting by making prints for all similar buildings from one set of tracings and then applying pasters covering the variations, had to be abandoned owing to the difficulty of keeping the great number of paster tracings, and of assembling sets of prints made up of the original sheets with innumerable pasters. There was also too great a liability to error.

Where the ornamental features of buildings of the same type are alike, the details for these are made in standard form, so that having once prepared tracings of these details for the first building they apply without change to any extent desired.

If all buildings could be made to conform to one or another of the standard types, plans could be produced with great rapidity, but unfortunately this is impossible. The present building schedule comprises five new buildings of Type A, one of Type B, two of Type C, three of Type E, six of no standard type, and seven additions. This schedule of 24 items, made up prior to the adoption of the type buildings, offers only seven opportunities for duplication. In future building schedules it is expected that greater use will be made of the standard types.

Buildings requiring additions are usually old, badly planned

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*From a paper presented Feb. 26 before the Municipal Engineers of the City of New York.

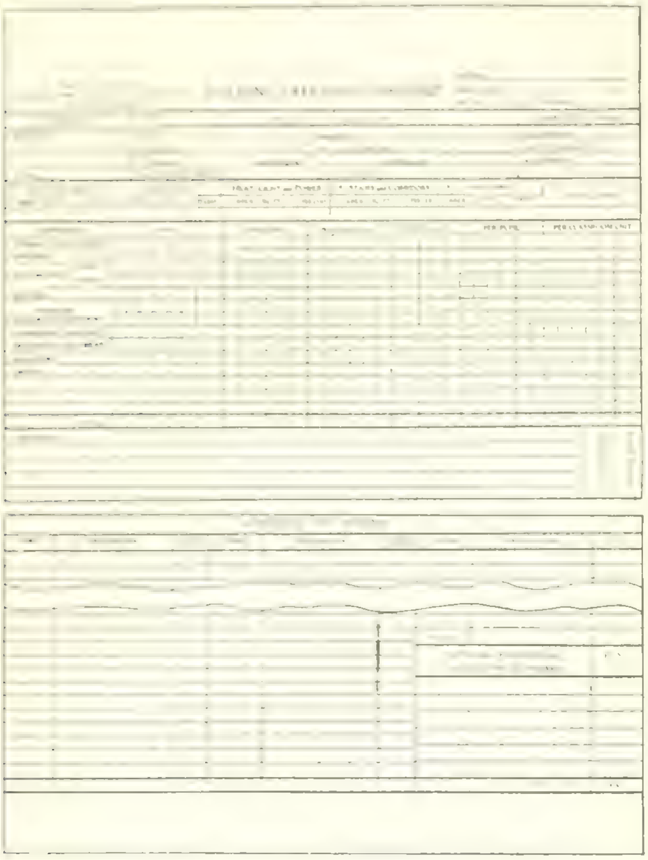
[illegible]

Before plans are given out for bidding they are made com[illegible] [illegible] The drawings [illegible]

[illegible]

All [illegible] contractors [illegible] bidder as [illegible] contract has been approved, which enables him to [illegible]

This practice insures complete checking, cross-checking [illegible] given out.



Face and Back of 8 ½-in. x 11-in. Building Efficiency Record Card. Complete Record of Each Building Is Kept on These Cards.

It also tends to lessen the number of extras on the contracts, due to omissions or errors. In proof of this it may be stated that in eight years' work, the contracts for which amounted to $28,000,000, extras of this kind amounted to only $24,000, or less than 0.1 per cent. When it is realized that the extras on one building frequently equal that amount, the advantage of complete, accurate drawings and specifications becomes apparent.

The adoption of the standard specification with amendments has resulted in a great saving in the labor and expense of writing, editing and printing the specifications. No time or thought has to be devoted to the standard specifications, which comprise about 80 per cent of the whole. It is only necessary to take care of the variations from the standards, or about 20 per cent.

By the exercise of determination and against the judgment of some of the men, it has been found not only possible, but advantageous, to limit the size of drawings to dimensions that are practical for drafting as well as for use on the building. It is [illegible] necessary for our draftsmen to recline full length on their work nor to wear carpet slippers so that they may walk on it. Neither is it necessary for the contractor to cut his drawings into sections before attempting to use them. Tracing cloth is purchased in sheets of standard size with a margin line and the department and signature stamp printed on each sheet. The printing is less expensive than lining, lettering and stamping by hand.

Payments on the contracts are made on the basis of 90 per cent of the amount earned at various fixed stages of the operation. The work included in these various payments, together with the percentage of the contract price to be paid, is printed in the specification. This method as distinguished from the usual monthly payments, has been found highly satisfactory, because it eliminates all controversy as to the amounts earned and all opportunity for contractors to obtain excessive payments as a preliminary to abandonment of the contract. In order to fix the percentages for the various payments, an accurate quantity estimate is made and this is segregated into the payments determined upon.

Hints on Storing Timber to Prevent Decay

Many serious losses from decay in wooden structures are possibly due to the fact that the timbers used were infected with wood-destroying fungi while in storage. These losses can be greatly reduced by keeping lumber storage yards in a sanitary condition. The following hints as to how to do this are given by the Forest Products Laboratory:

Strong efforts should be made to store the products on well-drained ground, removed from the possible dangers of floods, high tides, and standing water.

All rotting debris scattered about yards should be collected and burned, no matter whether it be decayed foundation and tramway timbers or stored lumber which has become infected. In the case of yards already filled in to considerable depths with sawdust and other woody debris the situation can be improved by a heavy surfacing with soil, slag, or similar material. Weeds should be cut away from the piles to allow good ventilation.

More attention should be given to the foundations of lumber piles in order to insure freedom from decay and better ventilation beneath the stacks. Solid foundations should never be used. In humid regions the stock should not be piled less than 18 to 24 in. from the ground. Wood blocking used in direct contact with wet ground should be protected by the application of creosote or other antiseptic oils or else replaced by concrete, brick, or other durable materials. Treated skid timbers would also be highly advantageous.

Foundations should be built so that the piles will slope approximately 1 in. to every foot of length.

In most regions lumber should not be close piled in the open, but should be "stuck" with crossers at least 1 in. thick. Lateral spacing is also very desirable. Roofing or cover boards on the piles should not be neglected, and should extend over for several inches in front and back.

Instead of throwing the "stickers" about on the ground to become infected with decay, they should be handled carefully and when not in use piled on sound foundations and kept as dry as possible. If pine saturated with resin, or the heartwood of such durable species as white oak or red gum be employed, the danger of possible infection will be greatly decreased.

In storage sheds the necessity for piling higher from the ground is very apparent in many cases. The same remedies apply here as for pile foundations in the open. The sheds should be tightly roofed and the siding should not be run down below the bottom of the foundation sills. Free air circulation should be allowed from all sides beneath the inclosure. Only thoroughly dry stock should be stored in close piles under cover.

Should fungus outbreaks occur in storage sheds not constructed to meet sanitary needs the infected foundation timbers should all be torn out and replaced with wood soaked in an antiseptic solution or by concrete or brick. In all cases the new foundations should be so constructed as to keep the lumber well off the ground, and the soil and timber immediately adjoining the infected area should be sprayed or painted with an antiseptic solution of a water-soluble salt, like sodium fluorid, mercuric chlorid, zinc chlorid, or copper sulphate.

Building Heights in the United States

An interesting resume of the regulations in various cities regarding the height of buildings is given by M. R. Fleming, engineer American Bridge Co., in the Journal of the Western Society of Engineers. An abstract of the paper follows:

The term "height of a building," according to the New York code means the vertical distance measured in a straight line from the curb level to the highest point of the roof beams in the case of flat roofs and to the average height of the gable in case of roofs having a pitch of more than 20°. According to the Chicago code for non-fireproof buildings it is measured from the average established sidewalk level to the highest point of the roof thereof and for fireproof buildings it is measured from the average grade of the street frontage of the building to the top of the highest point of the external bearing walls. Other definitions differing slightly from those of New York and Chicago may be found. Cornices, parapet wall, penthouses and bulkheads are not often considered in determining height, but building codes generally place limitations upon their height and area.

Frame buildings outside of fire limits are variously limited to 2, 2½ and 3 stories, or 35, 40, 45 and 50 feet in height.

Buildings having bearing walls of hollow terra cotta or concrete building blocks are limited to 3 stories and 40 ft. in height.

The code of Terre Haute has a clause, "No school building hereafter erected shall be more than two stories and basement in height." The code of Dayton fixes a maximum distance to the upper floor level for different kinds of buildings, the distance for the primary, grammar and high school buildings being 38 feet above the average grade.

A long list of cities fixes the maximum height for non-fireproof buildings at 65 or 70 ft. Kansas City (Kansas) allows but 50 ft. Detroit for a certain type allows 100 ft. In Rochester the height of a tenement house "shall not exceed by one-quarter the width of the street on which it stands."

The storm center of the whole subject of building heights is the fireproof commercial building. The factors that enter into its regulation are many and complex. Much has been written on the subject. The "Report of the Heights of Buildings Commission of New York City," 1913, is a book of 295 pages with maps, diagrams and illustrations. The literature on city planning that is becoming so abundant is at one in charging the skyscraper with being a detriment to the ideal city. The old idea that within his lot lines a man owned as far down as he could dig and as far up as he could build is being outgrown. His neighbors and the community now have an interest in the use to which he puts his property.

The arraignment against the high building, briefly stated, is that it shuts out sunlight from the street and opposite buildings, it puts the city to heavy expense in providing fire protection, water supply and sewage, it is the cause of congestion on the street, adding seriously to the traffic problem. There are also economic considerations raised by the disturbance of land values. This particular phase of the subject is ably presented in an article, "City Taxation and Skyscraper Control," by George L. Hoxie, in the "Journal of Political Economy," February, 1915.

Factors Influencing Control.—The matter of sunlight enters prominently into any proposed regulation limiting the height of buildings. How much sunlight shall be shut from the building across the street? The altitude of the sun at noon is equal to 90°—(Latitude + Declination). From this equation it is easily found that on the 22d of December a building 100 ft. high in New York City on the south side of a street running east and west shuts off the direct rays of the sun for a distance of 202 ft. from the base.

Two interesting charts are given in the report of a committee of the Minneapolis Civic and Commerce Association on Limitation of the Heights of Buildings. The first shows that if the south side of an 80 ft. street running east and west should be built up solidly with buildings 140 ft. high, similar buildings on the north side will receive no direct sunlight below the 10th floor for a period of several weeks in December of each year no direct sunlight below the 4th floor until after March 21st of each spring and no direct sunlight on the first floor except for a few weeks in June of each year. The second chart shows that the 12th floors of buildings 140 ft. high on an 80 ft. street running north and south have the greatest amount of sunlight, namely, 5 hours at the equinoxes, while the lower floors have the least amount, 1½ hours at the same date.

The natural angle of light is 45°. With this assumption a height no greater than the width of the adjoining street will not shut off light from the opposite neighbor. The code of New Rochelle, N. Y., has the provision, "No building shall project above a line of 45° from horizontal, taken from the building line opposite on the widest street on which it fronts." However, with natural light and sunlight a certain amount of reflected light is obtained. Assuming this at 15° we have a 60° light angle, which the Minneapolis report referred to above states should be the maximum angle used in establishing heights. This allows the height of a building to be 1¾ times (1.73 to be exact) the width of the street.

It is evident that if light alone were considered in limiting building heights, tower buildings would be shut out. "One of the glories of New York is its towers." A scheme proposed by the architect, Ernest Flagg, limits three-quarters of every plot of land to a building height not to exceed 1½ times the width of the street on which it faces with a maximum height of 100 ft. No limit is to be placed on the remaining portion of the plot. An owner is allowed to dispose of his right to build high in favor of any adjoining plot.

It has been suggested that volume be limited rather than height. A regulation worked out for the City of Houston is, "A building may occupy the entire lot to a height not exceeding the width of the principal street upon which it faces, and not exceeding in any case 100 ft. Above this height the cubage of the building shall not exceed one-fourth of such height multiplied by the area of the lot." ("The Regulation of the Height of Fireproof Commercial Buildings," by Arthur C. Comey in "Proceedings of the Fourth National Conference of City Planning.") This regulation does not seem to have been adopted; at least, it is not a part of the present building code of Houston.

In England and on the Continent the skyscraper is unknown. The maximum heights allowed in 29 European cities range from 43 ft. in Zurich to 82 ft. in Vienna. (Table in Report of the Heights of Buildings Commission of New York City.)

Present Limiting Heights.—A common limitation of heights of fireproof buildings is 2½ times the width of the street with an absolute limit. Boston has a commission on the heights of buildings. The first commisison was appointed in 1904 by an act passed that year the city was divided into two districts. No building in district "A" can be carried to a height of more than 125 ft. above the grade of the street; in district "B" the height is limited to 80 ft. The height of no building in the city may exceed 2½ times the width of the street. The Ames building, 189 ft. high, and two or three others over 125 ft., were built before the act of 1904 was in force. The litigation that arose from the Boston restriction forms an interesting chapter in legal history.

Other cities in which an absolute limit of 125 ft. is in force are Augusta (Ga.), Cambridge, Charleston, Kansas City (Kan.), Houston, Manchester, Portland (Me.), Seattle, Shreveport, Springfield (Mass.), Waltham and Worcester. Kansas City and Houston reduce the limit of 125 to 100 ft. if the building is used for stores, factories or as a warehouse. In Altoona no building can be more than 125 ft. high "except by special permission." Columbia, S. C., has a limit of 2½ times the width of the street with a maximum of 125 ft., "except it be used exclusively for an office building."

In Brookline the limit is 2 times the width of the street with a maximum of 80 ft. Fitchburg has an absolute limit of 100 ft. and Providence 120 ft. In Washington the height can not exceed 130 ft., "except on the north side of Pennsylvania avenue between First and Fifteenth streets, northwest, where an extreme height of 160 ft. will be allowed." Los Angeles, Pasadena, St. Louis, San Diego, Oakland and South Bend permit a height of 150 ft., though in the latter two the height may not exceed 1½ times the width of the street.

The code of Portland, Ore., has a classification of building heights based upon the occupancy of building and the ratio of height to least dimension at base. For skeleton frames the maximum height is 160 ft. and five times the least hori-

[illegible] not be exceeded. In [illegible] in Grand Rapids and Minneapolis, [illegible]; in [illegible]; in Denver, 180 ft.; in [illegible], Newark and Paterson, [illegible]; in [illegible], New York and St. Paul, 250 ft.

[illegible] horizontal [illegible] times its least [illegible]. In Lincoln the [illegible] horizontal dimension at the first floor level. In Seattle "the height of fireproof buildings, except as otherwise provided, shall be regulated by a successive reduction of the areas of the floors above the third floor."

The "Building Zone Resolution" of New York City, adopted [illegible] provides "For the purpose of regulating and limiting the height and bulk of buildings hereafter erected, the City of New York is hereby divided into five classes of districts: (a) one times district, (b) one and one-quarter times districts, (c) one and one-half times districts, (d) two times district, (e) two and one-half times districts, as shown on the height district map which accompanies this resolution and is hereby declared to be part hereof." As may be inferred, the width of the street is the base for determining height, although from 2 to 5 ft. may be added to the height of the building for every foot it is set back from the street line. On streets more than 100 ft. in width the same height regulations are in force as on streets 100 ft. wide. This makes the absolute limit 250 ft. as previously mentioned.

Cincinnati, Detroit, Louisville, Philadelphia and San Francisco are among the large cities in which there is no restriction upon the heights of fireproof buildings. The code of Detroit expressly states, "Fireproof construction buildings shall not be limited in height." The codes of San Francisco and Salt Lake City have a paragraph, "Class 'A' buildings with all wall loads above the third floor carried on the steel frame shall not be limited as to height."

The Skyscraper of the Future.—In 1910 only a dozen cities restricted the height of fireproof buildings. The number has now increased to 50. Other cities will doubtless be added to the list in a few years. A dominant factor in bringing this about will probably be the desire to stabilize property values. In a large city without restriction and already having skyscrapers, "the system of control to be adopted must, unless it be cruelly unjust, apply equally to the existing skyscraper and to new skyscraper construction. . . . The problem of equalizing the lot of real estate owners who have, and who have not, already put up skyscrapers is one of the most serious character." Had New York and other large cities taken hold of the subject 25 years ago, the situation would be far different from what it is at present. The obvious lesson for the smaller city is to ordain from the start the control that will probably be needed in its future growth. The state building code of Wisconsin will be quoted: "This is felt that-this is a matter of general community welfare code sets no limit to the height of a fireproof building, as it rather than the safety of the individual occupants. The Industrial Commission strongly recommends that each municipality adopt such a limit, before the rise in central land values makes such action a hardship to the property owner."

The altruistic suggestion has been advanced that no single freeholder should be permitted to build to a greater height than would be permissible for all others to build in a similar way. If this were done the height limit would be low, much less than the 125 ft. limit of Boston. Imagine long streets banked solidly on each side with 10-story buildings! If extended over wide areas the city would be uninhabitable. That such a condition should come to pass is too improbable to be anticipated.

However, ideal regulations for skyscrapers include limits for area as well as limits for height. A building that fully covers a lot is entirely dependent upon the adjacent streets and lots for light and air. If several adjoining lots are thus built upon there can be but an insufficiency of these essentials to convenience and health.

The City of St. Louis has recently passed an ordinance regulating the height, area and use of all new uildings. The city is divided into three types of districts: five heights istricts (known respectively as the 45-ft., 60-ft., 80-ft., 120-ft. d 150-ft. heights district), four area districts and five use tricts. The practical working of this latest word in city ing will be watched with interest.

Reduced Wages Not Necessary to Resumption of Building

That a reduced wage scale is not an indispensable preliminary to resumption of activity in the building trades is the opinion of Morton Chase Tuttle, who has just returned to Boston after more than a year of service as production manager for the United States Emergency Fleet Corporation. Mr. Tuttle bases his judgment on some very recent investigations of large construction enterprises located at various points from New England to Florida, supplemented by careful studies carried out under his direction by the Aberthaw Construction Co. of Boston, of which he is general manager. These unmistakably indicate that increased efficiency of labor is bringing down costs even while wages remain at existing altitudes.

"In the course of viewing numerous undertakings more or less closely associated with interests of the Government," says Mr. Tuttle, "I have lately been impressed to find the statement commonly made that costs of operation are beginning to show a noticeable decline. And this, almost without exception, was attributed to increased efficiency of the labor force, due in part to the opportunity for weeding out the less dependable workers, in part to the growing desire of all members of the force to retain their jobs.

"Owing to inadequate or otherwise unsatisfactory cost systems maintained in connection with most of these undertakings. I found it impossible fully to check the statement by actual figures. Accordingly, I asked my own company to make out the cost of any one process in an operation continued over a period of several weeks. That which was selected was a piece of concrete work; the costs studied were those for the common labor employed on this work from Jan. 7 to Feb. 4 of the present year inclusive. During this period the wage scale remained unaltered; but the personnel of the labor force underwent frequent changes.

"A graph of the labor cost of the work during the period noted shows a sharp and almost undeviating decline from day to day. On Feb. 4 these costs were exactly 50 per cent less per unit than were those of Jan. 7. It is my belief that the experience of my company is by no means isolated, and that in almost any labor force there lies the opportunity of realizing economies ranging from 20 to 50 per cent without interfering with the wage scale.

"This implies, of course, that there is now increased opportunity for selecting men according to their suitabilty for a given task, and an increased eagerness on the part of the men to make good. But this is as it should be, and the whole country ought soon to feel the effect of it in general improvement at all points. It is a case of supplanting so-called liquidation of labor by proper adaptation of labor as a means of keeping the cost of doing things within the bounds of utility.

"And in this connection it may well be urged that state of mind is often as potent a factor in ultimate labor costs as is the rate per hour. Any one experienced in handling workmen has recognized the difference in output between a cheerful, capable man, anxious to hold his place, and one who is a little disgruntled and quite conscious that he can get another job the moment he drops the present one. Multiply either case by thousands of individual instances and I believe that there will be found, in shifts of mental attitude, the explanation of much of the variation which occurs in unit cost. And this, after all, is the element of labor which directly affects the profits of the employer."

They Do Things in a Big Way in the Army.—A new use for construction equipment has been "invented" by an ingenious doughboy now with an engineer regiment in France. Writing to his home town newspaper he describes the army kitchen as follows: The building is 928 ft. long and 300 ft. wide and it takes 18 firemen to keep it warm enough to work in. We have 579 cooks and 700 on kitchen police duty. We mash our potatoes with a pile driver and grind our coffee with a 350-HP. Liberty motor. Our empty pans are hauled out on railroad trains. The kitchen police go around on roller skates. The mess sergeant rides around on a motorcycle shouting orders through a megaphone. Now for flapjacks, we mix the batter with 12 concrete mixers. We also have steam shovels moving egg shells away from the door and six kitchen police with bacon rinds strapped on their feet keep the griddles greased.

Bridge Substructure Construction With Concrete Caissons Sunk by Open Excavation Method

In the construction of ordinary railroad bridges it is frequently necessary to put the footings a considerable distance below the ground line, or the bed of the stream, in order to obtain a good foundation or to eliminate danger from scour. In foundation work of this kind the concrete caisson sunk by the open method of excavation has its field. The caisson can either be completely built over its final location, before sinking operations start, or it can be partly built, sinking started and additional sections of concrete added from time to time as the sinking progresses. If the location of the pier is in the wet part of the channel, the caisson may be built on temporary staging and lowered to position on the bed of the stream by means of lowering screws. In other cases the caisson may be built on an artificial island. An interesting discussion of the experiences of the Chicago, Burlington & Quincy Railroad with concrete caissons in bridge foundation work was given by Mr. L. W. Skov, assistant engineer, bridge department, in a paper presented before the Western Society of Engineers. The matter in this article is taken from Mr. Skov's paper.

Design and Construction of Concrete Caissons.—The walls of the caissons are designed for a variable unit load equal to that usually used in designing retaining walls holding an earth fill. In cases where a considerable head of water is expected the hydrostatic pressure is added to the above unit pressure. When the caissons are rectangular in shape, $\frac{w l^2}{8}$ is used for computing the bending stresses, no account being taken of continuity between the several sections of wall formed by the cross struts, no reinforcing being placed on the outside face of the caisson at points opposite the cross walls. While this is not theoretically correct, no signs of failure have been noted from this cause. The bottom of the sidewalls and interior struts are tapered down to a width of from 3 in. to 1 ft. on the bottom, to form a cutting edge. Where caissons are sunk through clay or sand it is customary to leave the concrete cutting edge unprotected; where gravel, rip rap or other hard materials are encountered the cutting edge is protected by steel angles or hardwood timbers, depending on the material through which the caisson is to be sunk. Steel protected cutting edges are not used except where the material penetrated is very hard and offers a great resistance as the hardwood cutting edge is found to give better protection to the concrete and on account of its greater width gives a much stronger caisson wall near the bottom.

One-half inch square bars, spaced about 1 ft. centers are placed vertically in the walls to tie the concrete together and to help distribute local loads over a greater area of wall. Openings are left in the interior walls of sufficient size to allow the free passage of men and tools from one chamber to another in caissons where the excavation is to be done by hand. The walls of the caissons are made of 1:2:4 concrete and the core of 1:3:6 concrete. The only reinforcing used in the core are the stub bars for tieing on the neat work. These bars are spaced about 2 ft. centers and are only counted on to prevent temperature cracks. In the larger caissons where the excavation is removed by the use of grab buckets or pumps, the interior walls are usually stopped off about 2 ft. above the cutting edge and no holes left between the various compartments.

In cases where caissons are sunk to eliminate danger of scour, it may be found necessary to drive piling to carry the load. In this case the piles are driven in the usual way, after the excavation has been completed. Caissons sunk under these conditions are usually full of water and require sealing around the piles with a tremie. After the concrete has sufficiently set, the water is pumped out, the piles cut off, and the balance of the caisson filled with concrete.

When it is desirable not to have the caisson project above the ground line a triple lap wooden cofferdam is built on top of the concrete caisson, the lower wale being bolted to the concrete. When the pier has been constructed it is an easy matter for a diver to remove this wooden crib by just unscrewing the nuts on the bolts holding down the cofferdam.

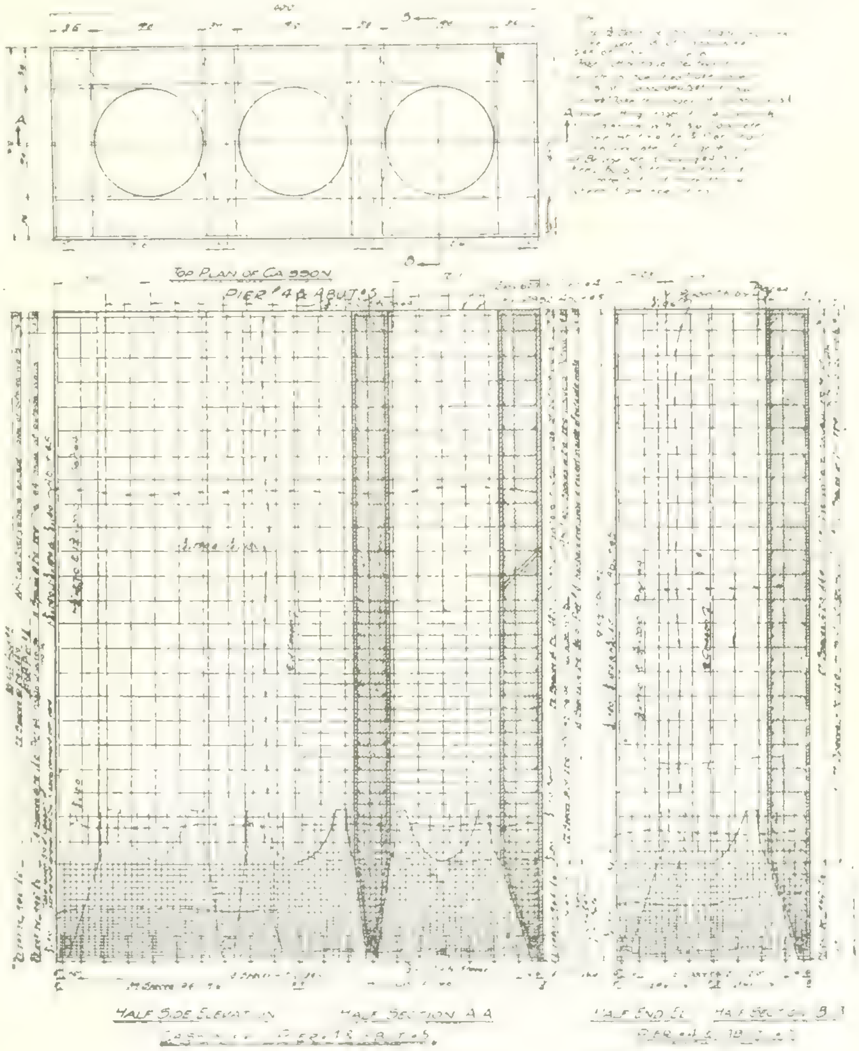


Fig. 1.—Type of Caisson for Sinking to Great Depths.

Methods of Sinking Caissons.—In one of the first concrete caissons, built in 1912, by the C., B. & Q. R. R., steel angles and plates were used to protect the concrete cutting edge, the cutting edge being made very narrow to insure sinking of the caisson by its own weight. It has, however, been found by experience that it is not necessary to employ as narrow a cutting edge as the one used for this caisson.

This caisson was excavated by hand, the material being removed by a hoisting engine having two nigger-heads placed on the ends of the drum shafts, from which ropes were run through sheaves attached to the old bridge, directly over the caisson locations. These ropes were provided with sling arrangements which hooked onto the wheelbarrow wheel and handles. The loaded barrow upon reaching the top of the caisson was pulled over to one side of a platform and then wheeled over and dumped on the river bank. The excavating gang consisted of 12 men, and an average of 12 cu. yds. was excavated daily. A boulder 4 ft. in diameter, resting on the bedrock and located directly under one of the caisson walls, was encountered. As the boulder rested on bedrock, it was thought best not to move it as this would require a great

[illegible]

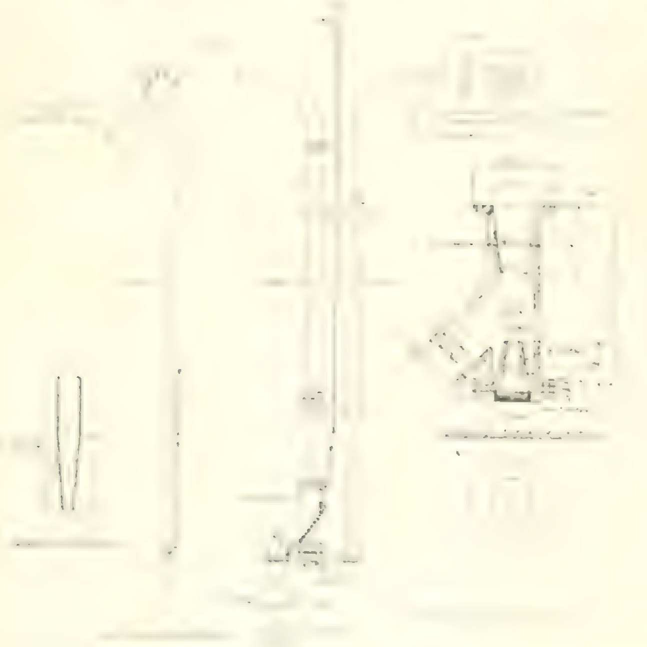


Fig. 2.—Details of Sand Pump.

[illegible] No opening was made in the strut wall as the caisson was not a very high one.

This caisson was hand excavated, the material being removed by shoveling in stages. As the caisson was sunk for the purpose of getting below the scour line, and as there was no hard ground here near the surface, softwood piles were driven to carry the load. This caisson was sunk through clay, and only a small amount of water was encountered.

In another caisson built in 1912, on account of the greater height, an opening for communication between the various compartments was built. This caisson was sunk through stiff clay, and for a while considerable trouble was being experienced in making the caisson settle. Even after the excavation had been removed below the cutting the box would remain suspended. It so happened that the old bridge at this point was a pile trestle, the new caissons being built between the old pile bents. The foreman one day conceived the idea that it would be possible to put up struts resting on the top of the caisson and long enough to reach the bottom of the stringers of the trestle bridge which would deflect under load, and then let a train across the bridge, and in this way give the box an initial start. This scheme was tried and worked very well. After the caisson was once started in this way the skin friction was reduced enough to allow it to sink down as far as the excavation had been made. Not a great deal of water was encountered. The piling was driven, and the caisson sealed as previously explained.

In the reconstruction of a bridge over the Black River near Lytle, Wis., the caissons were built on platforms resting on piling. The piles under the old truss were driven by a locomotive driver; the piles outside of the trusses were driven by a floating driver. The pilings were driven in a rectangle, clearing the outside dimensions of the caissons about 1 ft., the spacing varying from 5 to 7 ft. along the perimeter of the caisson. The piles were then cut to grade and capped with one 12-in. x 12-in. fir. timber halved at the joints and fastened to each pile with a ⅞-in. x 2-ft. drift bolt. Wedges 3 in. thick were placed on top of the cap at intervals of 3 ft. and a 4-in. x 12-in. bolster placed on them. On these 4-in. x 10-in. bolster stringers were placed 1-ft. 6-in. centers, with one 12-in. x 12-in. timber under each end wall. This construction was then [illegible] over with 2-in. x 10-in. plank and forms erected, reinforcing steel placed and concrete poured. The concrete was conveyed in ½-yd. dump cars run on a track built on the [illegible] beyond the trusses.

After a lapse of time sufficient to let the concrete set, the caissons were raised clear of the platform by tightening up the six 1½-in. lowering screws. The lowering screws were supported on pairs of old girders resting on pile bents driven outside the platform piles. The wedges were then removed thus leaving clearance to remove the plan flooring and stringers with ease.

Lowering was then started by simultaneously slacking up the nuts on the six suspension rods. This required 2 men for each screw using wrenches with gas pipe handles. The weight of the concrete alone in each of these caissons is 105 tons.

As these caissons could not be built more than 7 ft. high and clear the old bridge, it was necessary to extend them by the use of timber cribbing on top of the concrete, as lowering progressed. The caissons had to be lowered about 16 ft. before landing. This lowering was accomplished at the rate of about 1 ft. per hour.

The underlying material was sand and old logs; the sand was removed by submerged centrifugal pumps. During the sinking of one of the caissons 219 water-logged logs were encountered and were removed by breaking them up with a spud bar just outside of the caisson walls and then pulling them up through the inside of the caisson.

Next the foundation piling was driven under water, a locomotive driver being used for the piles coming under the old truss spans and a floating driver for the remainder; a follower was used in both cases. Upon completion of pile driving the caissons were sealed to a depth of about 3 ft., the concrete being deposited through a tremie.

The caissons were then pumped out, the piles cut off and the pier completed.

The caisson used from pier No. 8 of the Metropolis Bridge was the largest concrete caisson ever built by the Burlington. This caisson was sunk through a sandy clay to a depth of 50 ft. below the ground line where a sand foundation was obtained. Originally it was planned to sink this caisson about 35 ft., but when this depth was reached the soil was still unsatisfactory to carry the large loads coming on this pier, so it was decided to continue sinking until satisfactory foundation could be had at a depth of 50 ft. This caisson was started just before one of the greatest high water periods ever known on the Ohio River set in, and had to be temporarily abandoned as the water rose way over the top of it. After the water had fallen sufficiently to make the ground dry around the pier, work was again started. The timber cofferdam had been wrecked by the high water and was substituted by building an additional 16 ft. of concrete caisson on top of the original one. On top of this a timber crib consisting of 12-in. by 12-in. timbers laid one on top of the other was built. Struts of 12-in. x 12-in. timbers divided this crib into the same number of compartments as the concrete caisson below.

The excavation was removed by two clamshells operated from stiff-leg derricks resting on pile supports driven at opposite corners of the caisson. Upon completion of excavation, 129 soft wood piles were driven with long leads extending down into the caisson. The driver rested on top of the wooden crib and was easily moved from pile to pile. After all the piles had been driven the caisson was sealed through 40 ft. of water, a tremie being used.

After the concrete had sufficiently set the caisson was pumped out and the remainder of the concrete poured in the dry.

The caisson was not completely filled with concrete, but open pockets were left along the two sides of the pier, resulting in a considerable saving of concrete. Upon completion of the pier to the top of the concrete caisson the timber crib was removed, letting the dirt fall into the ???? ? ???? side pockets. All the timber was salvaged, which consequently made a pier strut without any timber struts running through it as would have been the case had open cofferdam construction been employed.

Figure 9 shows a type of caisson used where it is necessary to sink to a great depth. The caisson was built on an island of sand, pumped in from the riverbed by the same dredge that was used for placing the railway embankment along the river. Numerous soundings were taken at the location of the outside faces of the caissons in order to determine the exact shape of the rock bottom at the site of each pier. The cutting edges were then built to conform to these contours. This feature would greatly have complicated the framing of timber caissons.

The sand was removed partly by a clamshell operated from a stiff-leg derrick set up on piling driven before the temporary island was made and by the use of sand ejectors. The details for this are shown in Fig. 2. This ejector works on the same principle as the self-lifting boiler injector, except that a stream of water is passed through the nozzle instead of steam. The water was delivered through a 4-in. pipe line to the 3 2½-in. flexibles from a Deane duplex 10-in. suction 8-in. discharge pump set up on the river bank at the north end of the bridge. The pump was operated by an old locomotive boiler of about 100 HP. capacity and the water pressure was maintained at about 200 lb. per square inch.

The caisson was constructed to a height of about 10 ft.; the forms removed and sinking began additional sections 8 to 10 ft. high being added as the sinking progressed. The same forms were used 5 or 6 times and were made of wood.

At the time the sinking of the caisson for pier No. 5, or rather the north abutment, had progressed to within 6 or 7 ft. from rock, a strata of very hard, somewhat cemented sand was encountered which offered considerable resistance to sinking, as it would not flow away from under the cutting edge even when the center of the caisson was excavated considerably below the cutting edge.

The caisson was finally landed on rock after sand boxes containing a large amount of sand had been added to the top of the caisson, a trench from 5 to 6 ft. deep excavated along the entire perimeter of the caisson, the hard strata broken up by explosion of several half sticks of dynamite at various points by jetting and enough water pumped out to allow the material under the cutting edge to flow into the caisson.

Figure 3 shows a design of caisson especially adopted for deep foundation work. This caisson was one of several sunk in the Platte River near Ashland, Neb.

The new substructure consisted of 20 new piers, so located as to miss the old piers. Caissons for piers 6 to 16, inclusive, and pier 18 were made of reinforced concrete as shown in Fig. 3. All forms for moulding these caissons were of wood, and so constructed that they could be removed and used again.

The excavation was made with a clamshell bucket operated from a track derrick on the temporary bridge, or from a stiff-leg derrick and hoist, the latter being used wherever possible. After the removal of each 5 or 8 cu. yd. of sand a ½-lb. stick of 40 per cent dynamite was exploded in the excavated pit. By this method it was possible to prevent the sand from rushing into the working-chamber; and it seemed also to materially help starting the caissons to settle, after a depth had been reached where the skin friction was large.

The perpendicular position of the caissons was maintained by regulating the excavation in the bottom, and by the use of shores against the outside of the shaft. At times it was necessary to employ a diver to remove rocks, boulders, and logs from under the cutting edges.

The excavation was usually from 3 to 4 ft. below the cutting edge before the caissons would settle. In founding the caisson on the rock the last 3 or 4 ft. of sinking was done by lowering the water in the caisson, thereby causing the sand to be washed in under the cutting edge, and permitting the caisson to settle by its own weight to within a few inches of bedrock. The small amount of sand around the cutting edges which could not be removed was then thoroughly grounted with cement, applied through a 2-in. steam jet. The bottom was then sealed with a 5-ft. course of 1:2:4 concrete placed in the water by a ¾-yd. drop-bottom bucket. After this had set for 12 hours, a second course was placed, making a total of from 10 to 14 ft. of concrete in the bottom of the caisson. This was allowed to set 24 hours before the caissons were unwatered. After the caissons had been unwatered they were filled with 1:3:6 concrete. The piers were completed to proper height by placing reinforced concrete caps on top of the caissons, and anchored to them as shown in Fig. 3.

With a track derrick using 1 yd. Browning orange-peel bucket, a maximum of 6 ft. was sunk in 10 hours; with the stiff-leg derrick and hoisting engine rig, a maximum of 10 ft. in 10 hours was made. The loss of time with the track derrick on account of traffic amounted to 25 per cent. All the concrete caissons except two were started on artificial islands constructed as follows: a diversion dam consisting of brush and rock was placed in the shallow water just above the pier site. In the still water back of this dam a wooden cofferdam 24 ft. square, and from 4 to 6 ft. deep was constructed, and filled with sand, on which forms for the base of the caisson were erected. After sinking the caisson from 10 to 12 ft. the cofferdam was removed and reused for the next pier.

At pier No. 11 the water was 12 ft. deep. Here the caisson was constructed on a suspended platform, and lowered into place by means of six 2½-in. screws 24 ft. long. The platform was supported from two 60-ft. girders placed 13 ft. centers on pony bents set on the old bridge piers. The weight of the caisson was about 125 tons.

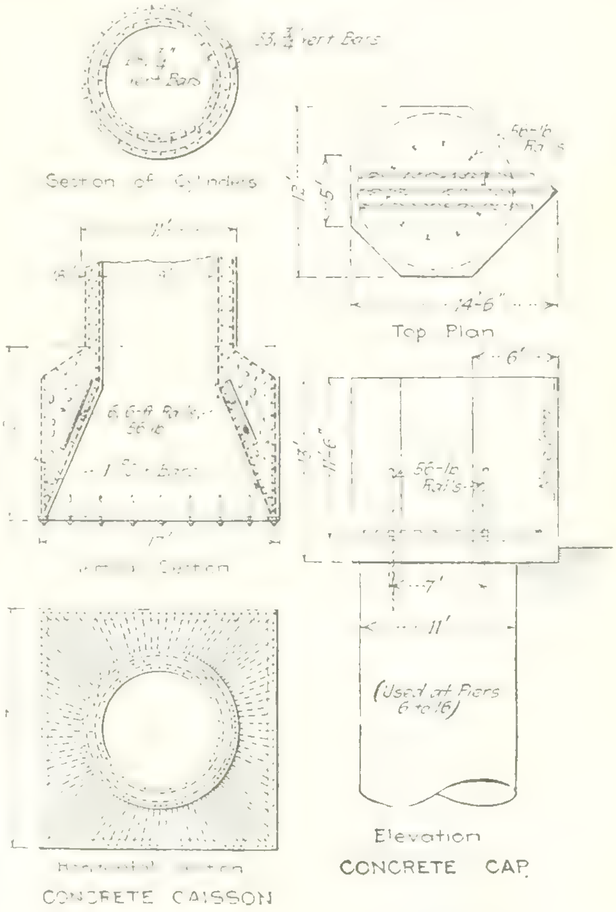


Fig. 3.—Caissons for Deep Foundations.

Pier 18, which was the last to be completed, presented many difficulties, owing to the fact that an old oak crib filled with rip-rap and sheeted with boiler iron on the upstream end, had tipped over and settled somewhat below the riverbed. Here a sheet pile cofferdam 19 ft. sq. was driven after the proposed line of the cofferdam sides had been sufficiently cleared of debris. The clearing was done by drilling holes 18 in. part, with a Davis Calyx core drill and exploding from 5 to 15 lb. of 60 per cent dynamite in each hole.

Upon completion of the driving of the cofferdam the debris was removed by the use of dynamite, divers, dredge buckets and sand pumps. When this work had been completed the cofferdam was filled with sand from the riverbed to a little above the water level, the forms for the caissons placed and concreted. Thereafter the work progressed without interruption.

Meeting of New York Chapter American Association of Engineers.—The New York Chapter of the Association will hold a meeting at 8 p. m., March 28, at the Hotel McAlpin, New York City. Mr. C. E. Drayer, National Secretary of the Association, will deliver an address.

Requirements of Slag for Aggregate in Concrete

[illegible] report [illegible] convention of the [illegible] In the report [illegible] requirements in [illegible] concrete.

[illegible] called for blast furnace slag, all others read so as to permit the prod- [illegible]

[illegible] type of material desired. This can be required without causing any commercial difficulties. When it comes to the matter of age or time of seasoning, the case is not so clear and the requirements vary. Some specifications demand a year's seasoning, others permit the use of the material after two or three weeks. The necessity for this depends on the nature of the slag. According to [illegible] a [illegible] slag (one containing only 1 to 2 per cent of magnesia) is not stable until seasoned for considerable periods, while a magnesia slag (one containing 4 per cent or more of magnesia) is commonly used within two or three weeks after banking, as no chemical change is apparent on exposure.

SPECIFICATION REQUIREMENTS FOR SLAG.

[illegible]	[illegible]	Origin.	Air cooled.	Age.	Weight, lb. per cu. ft.	Sulphur, not over Per cent.	Lime, not over Per cent.	Silica, not less than Per cent.
[illegible]		[illegible]	Yes	2 mo.	70	1.7*	48	33⅓
[illegible]			Yes	.....	65†	1.7	48	32
[illegible]			.....	1 yr.	..	...	..	..
[illegible]	‡	..	.....	.	74	..	..	..
[illegible]		[illegible]	Yes	. .	75	1.3	..	..
[illegible]	**		.....		70	1.5	45	32
[illegible]	**		.....	. .	65	2.0	45	32
[illegible]			.....	.....	..	2.0	45	30
[illegible]			Yes	††	68	...	..	..
[illegible]		...	.....	....	70	...	.	..

*No free sulphur, chemical analysis every 2,000 cu. yd. †After shaking to refusal. ‡Abrasion loss not more than ten. Factor of hardness not less than twelve. Factor of toughness not less than six. **Toughness not less than five. ††Live slag 3 months; Mag. [illegible]

The weight is the most definite requirement and concerning which there is the greatest uniformity; 70 lb. per cubic foot would seem to be a conservative yet reasonable figure.

Strength requirements are considered as impractical and without adequate precedent. Those discovered apply only to materials to be used in pavements where resistance to abrasion or surface impact is important.

Chemical limitations are placed in specifications for slag presumably to exclude materials containing unstable compounds or elements of a disintegrating or corrosive nature. The content of sulphur receives the widest attention in this regard and the limitation has been variously stated at from 1 to 2 per cent where it is covered in the specification.

The presence of unslaked lime seems to be of more vital importance since the presence of this material would obviously tend toward unsoundness of the slag on exposure to moisture unless neutralized by acid ingredients. It is because of this that some specifications place the limitations on the lime content and specify a minimum amount of silica to insure that enough of the SiO_2 radical shall be present to stabilize the CaO. As some users of slag are of the opinion that the seasoning of the material in a bank exposed to the weather would insure the elimination of any free lime and as there appear to be no test data available tending to demonstrate the adequacy and efficacy of these chemical requirements for sulphur, lime or silica, the committee does not feel qualified to make any definite recommendation in this regard.

In using slag in concrete it is necessary to include a requirement in the specification for the concrete that will insure proper proportions. Very strong concrete may be made with slag if the proportion of cement and fine and coarse aggregates is such as to provide high density, but owing to the porous nature of most slags, somewhat larger quantities of cement and fine aggregate will be required to obtain the desired density than is the case of most ordinary materials used as coarse aggregates.

Constructive Criticism of the Architect*

By F. W. FITZPATRICK.

It seems to me that, all summed up, everything considered, service should be the slogan, the watchword and the battle cry of the architect, and efficiency his aim in rendering the highest quality of that service. He is not manufacturing a certain grade of goods that the public can buy or leave alone; rather is he creating something special in every case that should be pre-eminently suitable to the particular purpose or wants of the client.

How thoroughly does the average architect do this?

All too often he deems the client merely a necessary evil, a nuisance; his lofty ambition is to erect beautiful buildings, monumental exteriors to his own skill in copying the work of masters of past times and conditions. He brings neither the experience with the varied problems of business or other specialized buildings, nor the earnest study these would justify, to bear upon the solution of the problem in hand.

He worships too fervently at the shrine of the Front. The plan, the client's greatest wants, the prime purpose of the building, the cost, the revenue, all must be beaten into shape or sacrificed to fit some wondrous exterior copied from great antiquity.

Strange what a fascination the past has for us. The old boys of aeons ago, other times and climes, built beautifully and appropriately to their times and climes. Their temples and tombs were refined, graceful, marvels of "frozen music," as architecture has been most aptly termed. Sometimes it took centuries to build those structures. Time counted for little. The world was leisurely romantic and offered much incense to the arts. But tell me, what sense is there in attempting to beat our intensely practical, rushed, modern and climatic requirements, every blessed one of them, into the external shape of some tomb or temple of B. C. times? Frankly, loving the classic as I do, enraptured as I am over it in its natural surroundings and settings, I've gotten so that, as beautiful and perfect as you can make a classic design, I am soured on it, tired and weary and sick at seeing modern office buildings, churches, schools, theaters, warehouses, residences, stables and dog kennels all a la Baths of Diocletian or Temples of Diana. Why not be consistent and clothe the ticket seller at your classical railway stations and the elevator boys at your temple-like office buildings in Roman togas, fillets, and sandals?

Granted that the wondrous buildings of the Chicago World's Fair and some of our great governmental structures gracefully fill and fit the classic garb borrowed from antiquity, still it at least shows most appalling paucity of expression that we should continue to follow that style right along and force it to do duty for our every need.

We go at architecture from the wrong angle, and the results are a bit heart-breaking. Grave errors and bungles are common in every profession and trade, for human nature is indeed most fallible, but it seems to be that in no profession are errors so common as in ours, unless it be in the medical one, and there they can at least bury their mistakes out of sight. No other profession involves so much detail, the blending of so many lines, the keeping together, the harmonizing of so many different forms of human endeavor, but all that presupposes the greater skill and more earnest preparations for all calling, yet as a matter of fact and exacting as are our duties, no profession is easier to butt into than is architecture. And there is so little check upon those errors until it is too late to mend them. Plans are something of a mystery to the average client. He sees a drawing showing a lot of rooms opening into a light-court, the latter is labeled "light," therefore he surmises that "light" really means light. Only when the building is completed does he realize that 3 ft. of space between two buildings 10 stories high doesn't really mean bona fide light. The architect should know it, but he wants light there, and fondly deludes himself that marking it on the plans will produce it in reality.

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*From The Architect and Engineer.

So with the costs. A man has $10,000 to spend on a building and for that $10,000 he'd like to get $20,000 of building. The architect aids and abets the illusion. He really hopes to produce the miraculous and he's afraid that if he doesn't promise the client the earth with a chunk of moon thrown in, his client will go elsewhere. The miracle is never performed. To get anywhere nearly what he wants, Mr. Owner will spend $30,000 perhaps where his architect talked $10,000. The profession gets cussed accordingly. I submit the architects should know the real cost of construction and should tell his client the whole truth.

So few prospective builders really understand a plan when they see it that it is not reasonable to expect an owner to know whether those plans truly supply their needs, whether they conform to the building code or not, whether the building will receive a high or low rate of insurance, whether it will really be fireproof or not, whether the construction is regular or expensively special, whether the light will be good or poor; all these things are left confidingly to the architect. Sometimes he manages to take good care of them, and other times he falls down miserably in one and often in a dozen particulars.

It is conceded that not one architect in a hundred really appreciates the importance of fireproof construction or knows all about its very simple essentials. At least the facts are that in this entire country, with something like 20,000,000 buildings in it, there are but 40 really fireproof buildings and certainly not over 8,000 fairly fire-resisting ones.

The profession's sins of commission and omission are indeed many and costly. Ornament is applied and where it adds nothing to the appearance of the building, just increased cost, waste; materials excessively strong in one place and barely adequate in another; so many rooms crowded in that the light space is insufficient for the entire building, resulting in large unrentable areas; arrangement sacrificed to external appearance; I have dozens of cases in mind where one or two rooms to every story in a tall building have been sacrificed, utterly spoiled, in order to get in some fool column or arch on the sacred "front." Everything is subservient to that "front"; and there's the inadequately heated building and the over-heated building; the leaky roof, the damp walls, the undrained cellar. And the sins of omissions; forgotten details, the hastily written or form-specification, made to do duty for every class of building, the inaccurate plans. the extras, the fusses with the buildings, the loss of time, rent and interest.

The architect should be artist and business man combined. His is not the function of merely interpreting a dream, as does a sculptor or painter, giving tangible expression to his thoughts and selling the product to whomsoever has the price; he does not build fantasies, buildings, and then place them upon the market. His function is infinitely more specific, more real, more commercial, if you will. The purpose of a building is decided upon before he is called in, it is very definite, it rarely is purely monumental, and almost invariably a building is planned to produce revenue, or to house some special function in life, a home, a house of worship, whose occupants have especial needs or notions and limitations that must be served. His is the task of putting those ideas into reality, of producing that revenue, of making convenient and easy of operation that factory or school. Advantages must be taken of the site already selected or owned, consideration must be given to the surroundings; a perfect structure, with all its complexity of details and specialties, must be produced, and the whole must be kept within a limit of cost that has been prophesied, anticipated by the architect. On top of all that, if he be a true architect, he will make that building beautiful, whatever its purpose, whatever its cost, however humble it may be. And such a task elevates his work into the most ideal, the noblest, the grandest, the finest of the fine arts, and, without exception, the greatest and most complex of all the sciences, for it must take into account and actually comprehend at least the rudiments or some of the details of them all.

Sad to relate, however, distressingly few practitioners in our profession look at it that way, who seem every to invert the process; they mistakenly put what they deem the "art" before the essentials, looking upon the latter as irksome, burdensome restrictions the owners of property cruelly put upon their great talent. To such an extent indeed that seven out of ten of them will begin the solution of a problem by blocking out a sketch of a beautiful exterior, a fine colonnade, an artistically balanced lot of "voids and solids," and then do their blamedest to beat the interior requirements into a shape that will fit that exterior.

All this may sound like a plaint, a bit of captious criticism, just fussing with the architects. I've told you before that I believed in constructive criticism; I show the sore simply that it may demonstrate the need of a salve or cure, and this paper, instead of being merely critical, is a most earnest and prayerful exhortation to the architects to devise and supply a cure, but it will have to be a mighty one, for it must be calculated to save the profession. In every large city one sees what is becoming of the architect. He is becoming the hired man of the big construction companies.

Many things are to blame for all this, some troubles within the profession and some outside. Among the latter is that the public is not discriminating in selecting an architect. Here is an example; it's a silly performance, but not at all out of the ordinary: A lady in Washington is going to build quite a mansion and has selected her architect. The man has done fairly good commercial work, but he never did a decent house in his life. Curiosity was eating me up and I asked her how she had made the selection. Her naive reply was that, not knowing any of them and getting such varied advice from her friends, she just took the directory and picked out a name that sounded artistic and clever, and the fellow certainly has a flossy, artistic hyphenated cognomen—albeit he didn't happen to pan out according to his ma's specification.

Some internal troubles are directly attributed to the schools. It sounds paradoxical and it is so, but they, the schools, are too severely academic. They give the wrong angle to the whole subject of architecture. The youngster is allowed to dally with castles and grand operas and just the fluff of architecture, and from the very first is impressed with the idea that Art is the Front, and that the proper way of putting up a good front is to make as nearly a copy as one can of something else done for an entirely different purpose 2,000 or 3,000 years ago.

Modern construction is looked upon as the province of the engineer. Modern, commercial, educational, manufacturing and religious conditions are bugbears to be tolerated but not loved and, in fine, the youngster is treated as a mere purveyor of pretty frills for a building, while his real task is far ahead and above that. He should be a creator, an artist if you wish, but also he must be intensely practical.

How many of us live up to that specification? All who feel that they are fully up to the standard may raise their right hands. Thank you, the ayes have it!

Aim by study and tireless effort to give your clients superior service, keep harping away at efficiency, be artistic but also be practical. True art in our line is to do all things well and to clothe perfectly articulated, muscled and fleshed skeletons in raiment that is suitable of today, and beautiful because it clearly expresses the purpose, the mode of life and character of the created thing. Take a larger part in public affairs, don't let the lawyers do it all; your training and your work fit you better than they are fitted to handle public improvements and the city's welfare.

Go after business legitimately and boldly. First prepare yourself to do your work well; do it so well that it speaks for itself and is your best recommendation and then tell people about it in a businesslike manner. The rules of the Institute are no longer against advertising. After you've done some good work, tell people about it, advertise it in a straightforward, direct way that will challenge and make appeal to a direct business man.

I have an architect in mind in an Eastern city who never lacks good and profitable work. When he hears of a building project he sends an ad to the man—a letter, telling him what his rates are, what he has done, gives his bank and other references, solicits his business, and encloses a list of 86 buildings, important ones, too, 80 of which have been com-

[illegible] of sisters-in-law, reverend and Masonic friends coming in to tell one how pleased they would be to have the job given [illegible]

How One Engineering Society Aids in Shaping Legislation on Matters of Interest to Engineers

[illegible] Society of Civil Engineers [illegible] a committee consisting of H. W. Buck, [illegible] and E. W. [illegible]h, Hartford, to watch legislative matters and to represent the society at hearings either for or against bills that the committee considered were those in which the engineers of the state were interested. The committee is supposed to use its discretion in these matters and to act promptly should occasion arise. At times it has appeared for or against measures on very short notice or preparation. Whenever the members of the committee appear at a hearing they very distinctly say that they are there to represent the engineers of the state and to give an engineering opinion after a careful study of the subject.

The two Hartford members of the committee endeavor to closely follow the bills introduced in the legislature and pick out those which might have an engineering side or bearing in their make-up. At the annual meeting of the society the committee comments on bills then current in the legislature and is able to receive a vote of the society instructing it to appear for or against certain projects. However, as mentioned above, the committee often has to appear at hearings on subjects which the society as a whole have not had the opportunity to discuss.

The committee has been influential in moulding legislation on the following subjects: Rewriting the law establishing the State Board of Civil Engineers having supervision over the safety of dams and reservoirs so that the board can organize and keep records and plans of dams constructed or repaired; reorganizing the State Board of Health, and the subject of giving them authority over the polution of streams and other sanitary matters; the placing of two engineers out of a total of six as members of the factory wastes commission, advocating the establishing of a state park commission, state parks and adequate appropriations for same; requiring that public records such as deed and mortgage records, etc., be kept in fire-proof safes or vaults, and for the suitable indexing of same; various bills in regard to the bridges and highways of the state, etc.

A few days ago a committee appeared at a hearing on a bill increasing the salary of state highway commissioner from $5,000 to $10,000 a year, and presented eight or ten letters on the subject in favor of the bill from prominent engineers throughout the state, and also had in attendance several engineers who spoke favorably at the hearing. In each case the engineers gave testimony regarding the great responsibilities of the office, as to the very efficient manner in which the present incumbent, Mr. Bennett, had filled the position and their opinion as to the value of engineering services such as this.

The highway commissioner of Connecticut is in sole authority in all matters pertaining to his department, which expends about $4,000,000 per year. Acting in a fiduciary capacity alone, he should be paid the $10,000 asked for in the bill, but in addition to this, he determines the broad policy of the department, the kind of roads to build, the location of trunk lines, the type of bridges to be built, the amount of repairs, etc., as well as being his own chief engineer on the design and construction of all this work. The engineers pointed these things out at the hearing, and gave testimony as to the value of services such as these, and also called attention to the very efficient manner in which Mr. Bennett had organized and conducted this work during the six years past which he has been in office. The committee of the legislature reported this bill favorably.

A similar appearance by the engineers will be made when this bill comes before the appropriations committee, and it is hoped that the legislature will raise the salary of the highway commissioner as set forth in the bill.

In passing, it may be of interest to say that Mr. Bennett has kept his department out of politics. Some years ago a bill was introduced changing the present single-headed commission to a three-headed commission, one of which was supposed to be a business man, one a lawyer, and one an engineer, the work of the commission being divided into three parts. It was apparently a move of the state politicians to place the highway department where it would be of the most use to them and the legislative committee with other engineers of the state appearing in force at the hearings regarding this proposed change had a large part in its defeat.

How an Individual Engineer Can Help Improve Conditions for the Profession*

By HARRISON P. EDDY,

Of Metcalf & Eddy, Consulting Engineers, Boston, Mas

I will tell you of my impressions gained from recent contact with engineers in the northern part of the country, between the Mississippi and the Atlantic Seaboard. The deepest impression was caused by almost universal evidence of a very general feeling of unrest—discontent—among the members of the engineering profession. It does not appear to be confined to any class or grade, but to be general, from the rodman to the chief engineer. The causes are not always evident and objectives are usually less clear. Prolonged discussion, however, has generally led me to the conclusion that the underlying cause of the discontent is compensation adjudged to be inadequate to the needs of the engineer, or disproportionately low for the services rendered and the education and experience required to enable the engineer to perform such service.

For example, in a small city in the Central States the city engineer called my attention to a railroad crossing tender who was paid $125 per month for raising and lowering the gates. The engineer did not state what his salary was, but the manner in which he spoke led to the conclusion that it was at most but slightly more than that of the gateman—yet this city engineer was supplying technical knowledge, skill and judgment for the successful handling of the city's engineering problems—the wise and economical expenditure of many thousands of dollars each year—in large measure safeguarding the property, limb and even the lives of the residents. Similar illustrations could be multiplied almost without limit. I believe they are general.

This feeling of unrest, which began to be evident in a small way several years ago and which has increased remarkably during the period of the war, has given rise to a great deal of study to determine what steps can be taken to ameliorate the hardships and to right the many cases of injustice.

Some have suggested the formation of a general engineering society or organization, which shall comprise all branches of the profession and which, by shear weight of numbers, will exert an important influence in raising the standard of the engineering profession throughout the country. This and other suggestions are worthy of serious consideration. All such movements are necessarily slow, and it is well for us to pause occasionally and reflect upon the things which have actually been accomplished. It will aid in an appreciation of the fact that progress has been made, if occasionally the engineer looks backward for a moment upon the things which have been done.

A few years ago the engineering profession was provided with an appropriate home, through the munificence of one of our masters of industry in this country. This was probably the first bond of union among the several branches of the profession. Its influence has been substantial, has grown remarkably and in the future will be of even greater value.

In 1917 Engineering Council was formed, through the cooperative efforts of several of the national engineering societies, with which others have since joined. The object of Engineering Council is to provide for the consideration of matters of common concern to engineers as well as those of public welfare in which the profession is interested, in order that united action may be possible.

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*From [illegible] Annual Meeting of the Binghamton (N. Y.) Engineering Society.

Within the past few months a National Service Committee has been established at Washington to discover public services which may best be performed by engineering societies; to speak authoritatively for Engineering Council before committees of Congress and departments of the Government, on all public questions of a common interest or concern to engineers; to circulate among engineers first-hand information regarding pending legislation and executive action, which may affect the interests of engineers; and to perform other services for the general good of the engineering profession. While the purposes of this movement have not yet been fully defined, no one seems to have questioned that there is a useful work for such a committee to do.

The American Society of Civil Engineers—which many engineers believe to have failed in large measure in its mission in this field—has attempted to meet current needs in part by the formation of local associations of members of the American Society of Civil Engineers. There are now 22 such associations.

This society has also within the past year created a Committee on Development of the American Society of Civil Engineers—one of its latest efforts to meet current needs. This committee has before it a great task. Let us hope it is not too great for successful accomplishment.

It must be evident to the rank and file of engineers that efforts are being made to improve conditions and that good results are to be expected from such a general forward movement, but we cannot all take active part in such special committee and society work, and the general body of engineers is anxious to have a personal work to perform. If advantage can be taken of this desire, great good will result, probably even greater good than that accomplished by the more formal organizations. It is pertinent to inquire what the individual engineer can do to help the cause along. From my observation there are several definite things which can be done. They are somewhat altruistic, but nevertheless, if undertaken by the engineering profession as a body, very beneficial results will certainly be obtained.

1. The engineer may strive to render better service, full measure of effort and excellence of workmanship. After all, these characteristics will go far in determining his position in the community.

2. He may avoid "knocking" his fellow engineers. I have been appalled recently to learn of the frequent criticism in unmeasured terms, heaped upon engineers by other engineers. This is particularly distressing and unfortunate when done in the presence of laymen, as has often been the case.

If the engineer must quarrel with his fellows—be it political or otherwise—the less publicity given to it the better it will be for the profession. If possible, differences of opinion should be straightened out by face to face conferences and never by ex parte mud throwing. Spirited discussions of opposing opinions may be had upon the floors of the engineering societies, but they should not be made a feature of parlor gossip. How often we have observed opposing lawyers engage in bitter recrimination to win the jury and then walk arm-in-arm to their offices. There is a valuable object lesson to the engineer in such conduct.

3. Our second point was, in a sense, a negative. It is desirable to go further and make a positive step in advance—not defensive but offensive. Let the individual engineer take advantage of every opportunity to speak a friendly word for other engineers.

4. Every engineer should be proud of his profession and should be prepared at all times to say a word in its behalf, for the profession was never more noble nor more deserving of popular respect than it is today. The man on the street, the woman at home, the public meeting, the household party, each will be interested in the engineer's work if properly described and presented. The failure of the engineering profession to command full recognition, is due to the popular lack of knowledge of the engineer's work more than to any other thing.

A line of activity which has been followed by a few engineering organizations, is that of taking an active interest in the solution of civic problems. In most cases the engineering society is peculiarly well qualified to render valuable service upon such matters. Notable among the societies which have undertaken work of this kind is that of the city of Cleveland, which has come to be recognized to such an extent that its advice is frequently sought by the city authorities before acting upon municipal problems of an engineering nature.

The action of the Binghamton Engineering Society in advocating the creation of a suitable memorial to the citizens of Binghamton who have served in the military forces of the country during the late war, is a very commendable effort in this direction. It places the Engineering Society before the public in a favorable light, and must tend to increase interest in the work of the society.

In closing I desire to give expression to my conviction that it is no time for a spirit of depression or pessimism but, on the contrary, that the prospect of the future public recognition of the work of the engineer should compel optimism and that if there be a concerted effort by the inidivdual members of the profession to serve as efficiently in times of peace as in war, little fear need be entertained that the engineer will fail to command the respect, the professional standing and the compensation to which he is justly entitled.

Cost of Painting Steel Truss and I-Beam Bridges

The cost of painting steel bridges for Franklin County, Iowa, in 1918, averaged $1.133 per lineal foot, according to figures compiled by Mr. F. S. Currie, County Engineer. This figure relates to the painting of 31 structures of an aggregate length of 1,639 lin. ft. All these structures with the exception of three of a total length of 175 lin. ft., were given two coats. The detailed cost of the painting was as follows:

	Total	Per lin. ft. of bridge
Cleaning	[illegible]	[illegible]
Painting	[illegible]	[illegible]
Paint	[illegible]	[illegible]
Team	[illegible]	.121
Miscellaneous	[illegible]	.015
Total (1,639 lin. ft.)	[illegible]	[illegible]

Table I shows the cost of painting each bridge. In the table Ic designates an I-beam bridge with concrete floor; PTw a pony truss with wood floor; HTa high truss and CC a curved chord. The small letters c and w denote wood or concrete floors. Bridge No. 7258 had a 20-ft. roadway and Bridge No. 11158 had an 18-ft. roadway. All other bridges had 16-ft. roadways.

As noted previously all except three bridges were given two coats of paint. The end posts and hand rails were painted white. The paint cost $2.50 per gallon f.o.b. Hampton, Ia. White lead cost $3.83 per gallon. Approximately 6 lin. ft. of bridge were covered (two coats) by 1 gal. of paint.

The foreman was paid 55 ct. per hour; painters, 32½ ct. per hour; one team was employed at 27½ ct. per hour.

The surfaces were thoroughly cleaned with putty knives and steel brushes. Radical variations in the table in relative costs for different lengths of spans are due to the fact that some of the bridges are set on tubular steel piers, and this of course increased the cost for the bridge, as these piers were painted.

TABLE I.—COST OF PAINTING STEEL BRIDGES IN FRANKLIN COUNTY, IOWA.

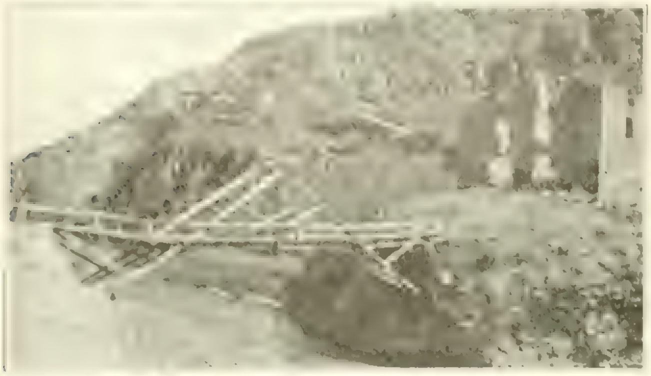
Bridge No.	Type	Length ft.	Cleaning per ft.	Painting per ft.	Paint per ft.	[illegible] per ft.	Total per ft.
[illegible]	I	16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	I	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9156	I-c....	21	.219	.300	.365	.130	1.013
9067	I-c....	21	.300	.300	.312	.153	1.065
1081	I-c....	26	.277	.277	.423	.120	1.097
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11242	PT-w....	40	.344	.244	.548	.155	1.291
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10184	PT-w....	40	.409	.311	.579	.153	1.452
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
13051	PT-w....	40	.360	.263	.579	.153	1.355
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7260	PT-w....	40	.300	.622	.375	.222	1.519
11158*	PT-c....	45	.130	.275	.322	.150	.877
10177*	PT-w....	60	.366	.210	.438	.126	1.140
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2045	PT-w....	50	.420	.378	.488	.153	1.439
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10107	PT-c....	60	.350	.478	.365	.181	1.375
9081	PT-w....	60	.240	.180	.292	.162	1.174
7186	PT-w....	60	.360	.240	.375	.130	1.105
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11128*	HT-w....	80	.221	.304	.281	.149	.956
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	HT-w....	80	.311	.270	.180	.136	1.147
7124	HT-w....	112	.245	.215	.357	.089	.937
2050	PT-w....	160	.256	.256	.349	.099	.962

Total [illegible]

A Home-Made Bridge in Spain

The bridge shown in the accompanying illustration spans the [illegible] River in the Province of Lerida, Spain. It is interesting as its essential members are roughly hewn logs and in its simplicity of "[illegible]." Moreover, it is the work of an unlettered Spanish peasant who erected the structure alone. That it occupies the [illegible] site of departed bridges the [illegible] of stone [illegible] across the river eloquently testifies. On the opposite bank may also be seen the ruins of what was in medieval times, a fortified bridgehead, [illegible].

The live loads supported by the bridge are such as are delivered by pedestrians, burros, flocks of sheep, etc., yet this structure did yeoman's service in affording passage of the river for much heavier loads during the diamond-drilling and tunneling operations of an American construction company a few years ago.



The Work of a Spanish Peasant.

Steel Prices Reduced

A 10 to 15 per cent cut in prices of iron and steel was announced on March 21. In announcing this reduction the Industrial Board of the U. S. Department of Commerce states: "In giving its approval to the schedule of prices just decided upon for the principal articles of iron and steel the industrial board of the Department of Commerce, carrying out the purpose for which it was created, believes that a level has been reached below which the public should not expect to buy during the current year."

Judge E. H. Gary, chairman of the committee of the American Iron and Steel Institute, which represented the steel industry in the conferences with the board, gave out a statement expressing the belief that while some of the steel plants would suffer temporarily because of the cut, they would more than make up the loss by increased business during the year He said he looked for "great business progress and prosperity in the near future." His statement in part follows:

"The objects to be secured are a revival and a stabilization of business by establishing a reasonably low basis of prices which would be satisfactory to the consuming public, and yet, so far as practical, would include a moderate and reasonable return to the investors where they are entitled to it in the application of sound business principles; and at the same time would not disturb wage rates or interfere with wages agreements; and further, having determined upon prices which it is expected will not be reduced during this year, it is believed that the volume of business will be promptly increased and that furnaces and mills will be operating at a largely increased capacity, thus giving employment to a correspondingly increased number of employes."

Among the price reduction are the following:

Rails, standard Bessemer, from $55 gross ton to $45; rails, standard open hearth, from $57 gross ton to $47; slabs, $46 gross ton to $41; skelp, sheared $3 per 100 lb. to $2.65; merchant bar base, $2.70 per 100 lb. to $2.35; sheared plates, $3.25 per 100 lb. to $2.65; wire rod, $57 gross ton to $52; plain wire, $3.25 per 100 lb. to $3; nails, $3.50 per 100 lb. to $3.25; black sheets, No. 28, $4.70 per 100 lb. to $4.35; tinplate, $7.35 per 100 lb. to $7; hoops base, $3.50 per hundred lb. to $2.45.

The reduction on pig iron, basic, announced last night was from $30 per gross ton to $25.75; billets, 4 in., from $43.50 per gross ton to $38.50, and billets, 2 in., from $47 to $42.

Culvert Openings and Drainage Areas

As the result of a partial study of the rainfall and types of soil throughout the state of Kentucky, the tentative table that follows was prepared by the Bridge Department of the Kentucky Department of Public Roads to show the standard sizes of culverts, their cross-sectional area, and the numbers of acres they should be expected to drain in the mountains in steep, hilly country, in rolling country and in flat sections.

SUGGESTED SIZES OF STANDARD CULVERTS FOR DRAINAGE AREAS.

Dimensions	Area Sq. ft.	Mountainous Acres	Hilly-steep Acres	Rolling Acres	Flat Acres	Min. head room.
18" pipe	1.77	1.0	2.0	4.5	9.0	*
2'x1½' con. box	3.00	2.0	4.0	7.1	18.0	1' 6"
24" pipe	3.14	2.5	5.0	10.0	20.0	*
2'x2' con. box	4.00	3.0	6.0	10.8	27.0	1' 6"
3'x1½' con. box	4.50	3.8	7.5	11.1	32.0	1' 7"
3'x2' con. box	6.00	5.3	10.5	18.6	47.0	1' 7"
2½'x2½' con. box	6.25	5.5	11.0	19.3	50.0	1' 6"
4'x2' con. box	8.00	8.0	16.0	27.3	70.0	1' 7"
3'x3' con. box	9.00	9.5	19.0	31.9	82.0	1' 6"
4'x3' con. box	12.00	12.5	27.0	46.7	120.0	1' 7"
5'x2½' con. box	12.50	15.0	30.0	49.3	125.0	1' 8"
5'x3' con. box	15.00	17.5	37.0	62.9	160.0	1' 8"
6'x2½' con. box	15.00	17.5	37.0	62.9	160.0	1' 9"
4'x4' con. box	16.00	20.0	40.0	68.5	175.0	1' 7"
5'x4' con. box	20.00	28.0	56.0	92.2	230.0	1' 8"
6'x4' con. box	24.00	35.0	70.0	117.5	300.0	1' 9"

*Depends on kind.

Note—Head room shown indicates thickness slab and cushion of fill and metal.

These openings, stated Mr. Charles D. Snead, Bridge Engineer of the Department in a paper presented at the recent Kentucky Road School, have been more or less checked out from existing drains which have proven inadequate and from new structures which do not appear to have been much, if any, too large.

Personals

Lieut. Thomas Maddocks has been appointed state engineer of Arizona.

Robert A. McKenzie, for the past 11 years building inspector of Vancouver, B. C., has resigned and has accepted a position with a large construction company engaged in work in China.

Oscar N. Newstrom, architectural and industrial engineer, has returned to Minneapolis after completion of his work with the McDougall Duluth Co., shipbuilders and engineers, and has located in temporary offices at 734 First National Soo Line building.

A. C. Stewart, 2022 Elm street, Youngstown, O., and Charles Spoon, 409 West Lafayette street, Youngstown, have organized the firm of Stewart & Spoon, and will engage in a general contracting business, specializing in excavating, masonry and concrete work.

Maj. C. B. Stanton, formerly professor of civil engineering at the Carnegie Institute of Technology, who has been with the Fifteenth Engineers in France nearly two years, has been appointed a professor in the American University for American soldiers at Beaune, France.

S. F. Kosters, for several years in the engineering department of Swift & Co., Chicago, and recently in an engineering regiment in France, has been appointed chief civil engineer of the South St. Joseph (Mo.) Stockyards Company. He succeeds Harold E. Worsley, who died three weeks ago.

Milo S. Ketchum, assistant director of U. S. Government Explosives Plant, and who since February, 1918, has been in charge of the construction of the smokeless powder plant at Nitro, W. Va., has returned to the University of Colorado, where he is dean of the College of Engineering and professor of civil engineering.

C. W. Price has been elected general manager of the National Safety Council, succeeding W. H. Cameron, who resigned to become manager of industrial relations for the Eastman Kodak Co. Mr. Price spent 12 years with the International Harvester Co., the last four years of which he was in charge of safety work for all the plants. For five years he was assistant to the Wisconsin Industrial Commission, during which time he worked out the standards on safety and sanitation, conducted educational safety campaigns in the large industrial centers and organized safety in the larger plants. For the past 2½ years he has been field secretary for the National Safety Council.

Maj. K. C. Grant, Construction Division, United States Army, has received his discharge and returned to Dayton, O., where he has become a member of the firm of Frank Hill Smith, Inc., Engineers, specializing in the design and construction of reinforced concrete industrial and mercantile buildings, with offices at Dayton, O., and 120 Broadway, New York City. Maj. Grant entered the army as a captain of engineers in April, 1917, and has since been in charge of important construction work, at first with the Signal Corps and later with the Construction Division. Before entering the service he was division engineer with the Miami Conservancy District, Dayton, O. He is a civil engineering graduate of the Massachusetts Institute of Technology, class of 1902.

Maj. Geo. W. Blackinton, formerly office manager at Denver for the Sullivan Machinery Co., has been awarded the distinguished service cross by the United States War Department, according to recent advices from Washington. The official citation follows: "Maj. Geo. W. Blackinton, 353d Infantry. For extraordinary heroism in action near Xammes, France, Sept. 12-13, 1918. Having moved his battalion to an advanced position, in accordance with orders, Maj. Blackinton found himself without support on either flank and no supporting machine guns or artillery, two kilometers in advance of our main front line. In spite of his perilous situation this officer, with the utmost coolness and good judgment, set to work intrenching and consolidating the position, determined to hold it at all costs, though his battalion was subjected to artillery and machine-gun fire and was threatened by counter attack by the enemy in force."

Road and Street Monthly Issue

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The *articles* in the first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering and contracting field. The *articles* in the first and last issues of each month (1st and 4th Wednesdays) completely cover county engineering and highway engineering and contracting. The *articles* in the third and last issues of each month (3rd and 4th Wednesdays) completely cover steam and electric railway location, design and construction. See the "mast head" on the first page of the Weekly News Section for information about our weekly contract news. See Advertising Page 77 for Subscription Coupon.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power

Railways and Excavation—3rd Wednesday
(a) Excavation and Dredging
(b) Rivers and Canals
(c) Quarries and Pits
(d) Railway Construction—Steam and Electric

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbors Structures
(d) Miscellaneous Structures

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Has the Los Angeles Municipal Cement Plant Been an Economic Success?

Ten years ago a municipally owned cement plant that cost $890,000 was put into operation by the city of Los Angeles. The property is about to be sold, $450,000 being the minimum bid that will be considered.

Designed with a daily capacity of 1,200 bbls., this cement plant was built to provide cement for the Los Angeles aqueduct, the theory being that the cement manufacturers were asking so exorbitant a price that the city would profit by making its own cement. Evidently the Aqueduct Bureau still believes the theory was justified by the results, even though the plant may be sold at half what it cost; for in a recent issue of "Pacific Municipalities," Burt A. Heinly, secretary to Chief Engineer Wm. Mulholland, Dept. of Public Service, Los Angeles, says: "The Aqueduct Bureau never contended that it could make a better cement than any private company nor did it assert, for reasons explained in the following, that a municipal mill could produce cement at a cheaper price per barrel. It did claim, however, and with good reason, that it would manufacture at a cheaper price per barrel than the price at which private mills would be willing to sell if the city should not own and operate a cement mill.

"It has been the claim of Aqueduct engineers, and in this one cement manufacturer has candidly agreed, that even had the Monolith plant not ground a single barrel of cement, it paid for itself in protecting the city from exorbitant prices."

On the other hand California cement manufacturers have contended that this municipal cement plant has proved to be a very unprofitable experiment in municipal ownership. It has produced less than 1,200,000 bbls. during its 10-year life. If the plant is sold for $450,000, a depreciation of $440,000 will have been suffered. The interest on the investment at 5 per cent simple interest for 10 years amounts to another $445,000. The sum of interest and depreciation alone would therefore total $885,000 or about 75 cents per bbl.

At the time the city was manufacturing cement, private companies bid as low as $1.12 per bbl. at their mill; and after the city ceased (in 1909) manufacturing cement it paid $1.45 per bbl. at Mojave for 200,000 bbls. as a result of threatening to resume manufacturing. Prior to making this threat the cement manufacturers had bid $1.85 per bbl. That the city paid $1.45 per bbl. rather than resume manufacturing cement is significant as to the cost to the city for operating its own plant.

We hold no brief for the California cement companies. It may be that they did conspire to hold up cement prices. But we are a long way from being convinced that the building of this municipal plant was justified.

The city may point to the 40 cts. per bbl. saved on 200,000 bbls. purchased in 1909, or a total of $80,000, as a result of its threat to resume manufacturing cement. But what of the annual $88,500 interest and depreciation on the plant every year of its 10-year life?

The city says that at the time it was receiving bids of $1.12 per bbl. for cement at the mills contractors were paying the same mills $1.86 per bbl. The apparent inference is that the cement companies were therefore making an excessive profit of the difference between $1.12 and $1.86, or 74 cts. per bbl. Yet this is by no means a sound conclusion. The cost of producing anything with a plant decreases as its load factor increases. Hence a plant operating at, say, half its full capacity and making only a fair profit on a price of $1.86 per bbl. might be able to make a fair profit at $1.12 per bbl. on every barrel in excess of its 50 per cent load factor output. Perhaps it is not an ideal thing to make a price of $1.86 to one buyer and a price of $1.12 to another buyer, but it may be that the total profit resulting from these two prices is not [illegible]

Civil engineers inexperienced in industrial economics are [illegible] they are two different [illegible] of the same com- [illegible] would do well to [illegible] production costs but the theory of regarding as a by-product all production in [illegible] by-product theory that [illegible] American [illegible] manufacturers to sell at a lower price in Europe than in America. It is this same theory that has led electric companies to sell current during "off peak" [illegible] than during peak load periods. It is this theory that led Vail to introduce the "night letter" message price that is one-fifth the ordinary 10-word day message price. It is this theory that explains many of the otherwise puzzling discrepancies in railway freight rates.

The average civil engineer knows very little about load factors, and even less about the pricing of products or services so as to increase load factors. It behooves him to study such economic matters before he condemns manufacturers for quoting different prices.

Los Angeles engaged in the business of making cement, acting under the advice of Mr. Mulholland. Nearly a million dollars was invested in a cement plant that has been idle for many years. Was this experiment justified? We doubt it. After the plant is sold it would be well were the city to employ a disinterested engineer to investigate and report not only the actual cost of the cement made in this plant but the saving to the city in the cost of cement purchased from private plants. A great experiment in municipal manufacturing should not be allowed to end without definite knowledge, from an impartial source, as to its economic justification.

What Can Be Done to Protect Contractors from Ignorant, Cut-Throat Competition?

The cost-plus-a-fee contract has been condemned by Congress, for in the Army appropriation bill for 1919 this form of contract is prohibited except when it is impracticable to apply any other form.

To those that are acquainted with the very high cost of much of the work done for the government under "cost plus" contracts, this action of Congress is not surprising. There is a grave defect in the ordinary "cost plus" contract. The contractor is neither rewarded for economy nor penalized for lack of it. Any basis of compensation that ignores the economic law of "payment proportionate to performance" is not ideal, to say the least.

Yet "cost plus" contracts have decided merits, whereas much can be said against unit price or lump sum contracts secured under cut-throat competitive conditions. Doubtless both forms of contract can be improved. "Cost plus" contracts can be bettered by the introduction of penalty and reward clauses. Unit price contracts can be improved by eliminating ambiguous clauses and by providing sliding scale prices dependent on changes in wages and material prices. Furthermore, incompetent bidders can be largely eliminated by requiring surety company bonds, and by permitting the engineer of the work to blacklist inexperienced, incompetent or dishonest contractors.

No public works contractor should be permitted to furnish bonds other than through a bonding company, for there are too many ignorant people—usually relatives and close friends of the bidder—who can be persuaded to act as bondsmen; whereas surety companies are much more competent to judge the responsibility of a contractor. Perhaps it would be well were surety companies forbidden by law to accept any property of the contractor or his associates as security for a bond. That would force the surety company to write bonds only for contractors whom they regarded as being thoroughly competent.

Chicago contractors are contemplating organizing a mutual bonding company, and the idea seems to have merit. They have already founded a mutual accident insurance company that has thus far proved economic. A mutual bonding company would have the merit of excluding incompetent contractors.

Highway contracting is no more risky than many another business, but it attracts a new lot of inexperienced bidders every year. The result is that in most localities experienced contractors do not remain long in "the road game." Inexperienced men usually get the jobs at prices that are too low. In the long run this is bad not only for contractors but for the public.

In an effort to escape the cut-throat competition of incompetent or dishonest contracts, many contractors have adopted the "cost plus" contract. When this form of contract has a penalty and bonus clause, it is usually very satisfactory. But unless the public is willing to place entire reliance in the judgment and integrity of the officials who award the contracts, the "cost plus" contract is not likely to prove satisfactory for general use. Under a "cost plus" contract the award is not based so much on lowness of the "plus" or fee as on the competence and trustworthiness of the contractor. Hence this form of contract offers a splendid chance for the public press to accuse the awarding officer of favoritism or even collusion and fraud. Any one who has occupied a responsible public office will see how serious is this objection to the general use of the "cost plus" contract for public works.

Being practical men we should not forget that nearly every city, county and state has laws that prohibit the use of any form of contract that does not involve the award to "the lowest responsible bidder." There stand the laws. It will take a long time to repeal them. May it not be better first to amend them moderately? Was not the recent action of Congress indicative of the most practical procedure? Let the present general method of calling for unit price or lump sum bids be retained as the common method, but with permission to use the "cost plus" method in special cases. Then secure a further amendment that will give real significance to the term "responsible bidder."

The expression "responsible bidder" should be either defined, or enlarged, or both. It might be enlarged to read 'finacially responsible, reliable and experienced contractor." To this might be added that the engineer in charge shall be the sole judge of whether a bidder is financially responsible, reliable and experienced. And finally, as an essential test of responsibility, it should be required that the contractor furnish bonds signed by a satisfactory surety company.

Should Civil Engineers Be Licensed?

About ten years ago American engineers began seriously to discuss the question of state license laws to control the practice of engineering. Louisiana passed such a law in 1908, and four more states have followed that precedent. There is clearly a growing disposition on the part of civil engineers to favor the licensing of civil engineers.

Civil engineers in the field of structural engineering find themselves in competition with architects who are protected by license laws. Civil engineers in the county and municipal fields encounter the competition of men that are not engineers at all. There are hundreds of city and county engineers who could not pass the simplest sort of a civil service examination, but hold their positions through political pull or because they were elected. Civil engineers perceive more clearly than any other class of engineers the need of some sort of law licensing those that practice civil engineering.

Eight years ago the board of directors of the American Society of Civil Engineers declared that it "did not deem it necessary or desirable that civil engineers be licensed in any state." We doubt whether the same board would adhere to that belief today. We believe that a ballot by the members of the American Society of Civil Engineers would show a large majority in favor of licensing civil engineers. Would it not be wise to take such a ballot after permitting proponents and opponents of license laws to present their reasons? Surely the question of licensing engineers is important enough to warrant taking such a ballot.

In this issue will be found a preliminary report on licensing engineers, by L. K. Sherman, chairman of the committe on legislation, American Association of Engineers. Read the report, talk it over with other civil engineers. Come to a decision. Act upon your decision.

The New Director of the Bureau of Public Roads and His Inadequate Salary

Engineers will be greatly pleased to learn that an experienced highway engineer is to become the Director of the Bureau of Public Roads, succeeding the late Logan Waller Page. In another column is given a brief biography of the new Director, Thomas H. MacDonald, at present chief engineer of the Iowa State Highway Commission.

There was some fear that the successor to Mr. Page might be a politician instead of a highway engineer. We are glad that this fear has proved groundless. But what did engineering societies do toward securing the appointment of an engineer to this important federal positions? What are they going to do to secure an adequate salary for its incumbent?

The salary of the director of this great bureau is pitifully inadequate. It is only $4,500 a year. Considering the importance of the position and the technical skill involved, the salary should be at least $15,000 a year. But we may be sure that so long as cabinet officers receive only $12,000, it will be hard to convince a $7,500 congressman that any federal engineering position should carry with it a salary of more than $10,000. Nevertheless the effort should be made by engineering societies to secure an adequate salary for the Director of the Bureau of Public Roads.

"It Is Your Patriotic Duty to Buy Horses"

"My fellow citizens, it is your patriotic duty to buy horses. There are many horses rendered idle by the cessation of the war. Buy them, feed them, make them comfortable, and take as much pleasure as you can in doing so."

Thus speaks an imaginary political orator. Whereupon an imaginary listener shouts: "How many horses are you going to buy?"

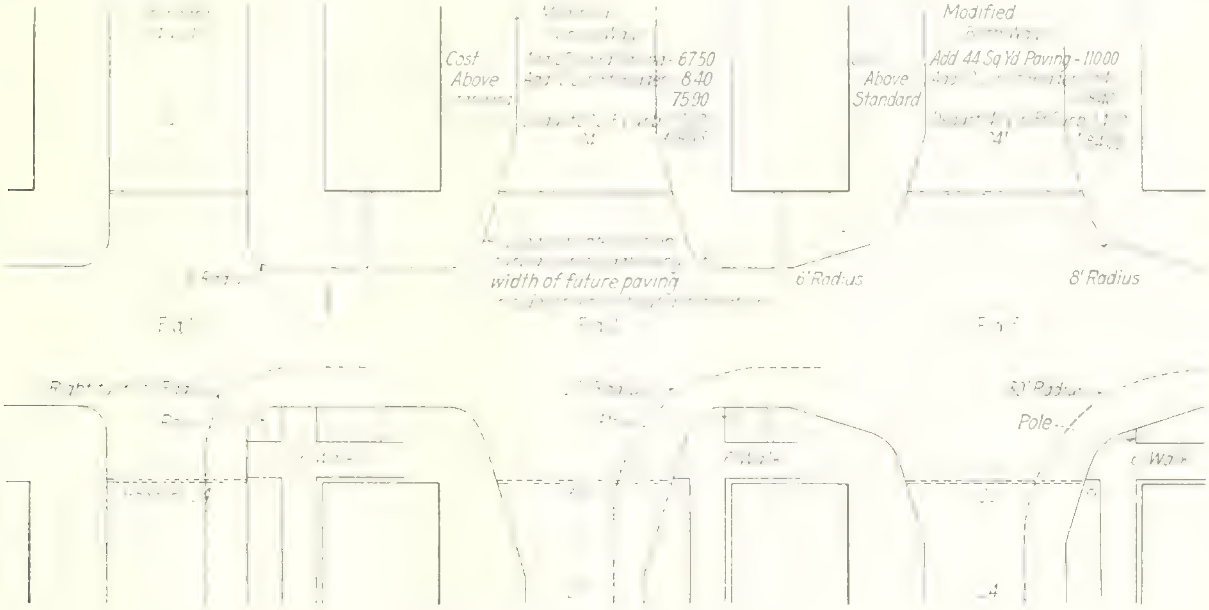
"Me? Why, I don't intend to buy any. My province is to tell others what to do."

For the imaginary political orator, substitute Uncle Sam, and for the imaginary questioner, substitute yourself. How would you feel about his reply? Well, as D. A. Garber, president of the Associated General Contractors, recently pointed out, the federal government has been calling upon the cities, counties and states to hire a lot of men, buy a lot of materials, and do a lot of construction, but precious little has the federal government itself undertaken to do.

If the engineering societies of America wish to perform a truly great public service, let them speedily outline definite plans for public works throughout America, and present those plans to legislative and administrative political organizations. Let engineers do a little less talk about being leaders, and lead. The public was never more in need of leadership in formulating policies for public improvements. A few local engineering societies have perceived this fact and are taking action. But what are the numerous other local societies doing? What are the national engineering societies doing? Talk is not enough. Definite plans for extensive public works, supported by convincing economic data, are needed by the the public. Who can supply this need better than the engineering societies of America?

Study for Modified Paving Intersections

To the Editor: The accompanying sketch shows a study I am making of intersections for paving in village streets. The study is being made with the following points in view: Securing increased room in the intersections for the turning and movement of automobile traffic and, second, consideration of the feasibility of narrowing the main run of the paving and effecting a substantial saving in cost, at the same time maintaining at least equal facility of movement on the whole by virtue of the enlarged intersection. An outline of the conditions is as follows:



Standard and Modified Intersections.

Space in the intersection modified both ways as in Fig. 3 would compensate to light automobile traffic in residence streets for narrowing the paving from 24 ft. to 22 ft. or 20 ft. Narrow paving leaves more room for grass, trees, pipes and other conveniences back of the curb. Grass and trees in place of brick are cooler in summer, less dust, farther from the house and perpetually cost less to keep clean and therefore are kept cleaner. At present estimates the intersection Fig. 3 costs the town $84.40 more than standard. The narrowing of the paving from 24 to 20 ft. for a standard block of 300 ft. would save the property assessment 133 yd. paving at $2.50, or $332.50, about 55 ct. per foot, or $27.50 to the 50-ft. lot.

I shall be glad of any comments from your readers.

C. E. VAUGHN,
East Palestine, Ohio. City Engineer.

How to Determine When to Repave

To the Editor: Referring to your leading editorial of March 5th, 1919, "How to Determine When to Repave," I would offer some further criticism of Mr. Tillson's asphalt assumptions—18 years life and an ultimate repair rate of 19 cents per square yard, even if deduced, as both are somewhat at variance with our Buffalo experience. We are surely getting an average life of 23 years on asphalt pavements laid under all varieties of conditions and in a vigorous climate. An ultimate rate of 19 cents for final repairs on an assumed life of 18 years would indicate that these repairs had largely been made within a few years and should constitute a practical resurfacing, making repaving unnecessary.

While we do [illegible] as that it is with the expectation that a thorough repair will put the street in condition for several years service at a much lower rate.

We have had over [illegible] yard years' experience in as [illegible] maintenance—all fully recorded.

I admire your theoretical determinations but for immediate and practical use on a large number of streets I favor the method of my article in Engineering News of Sept. 26, 1912. Without working out a continuous cost curve it is only necessary to know the cost of [illegible] to date. It may be set forth as follows:

Cost of top (new or old) say $1.50 per yard; at end of 20 years 70 ct. have been expended in repairs, the total cost of [illegible] is then $1.50 + $0.70 = $2.20 for 20 years or 11 ct. per year. If repairs are running up to this amount then give the street a detailed study. In some cases it will be found that the entire top is in a generally poor condition—then repave. But if it is found that much of the surface is in sound condition and even slightly more than the indicated maximum will put the street in serviceable condition for several years with only minor repairs then such action is warranted.

Careful study of the printed records of about 750 different contracts, where repairs are determined by the same men over a long period, fails to show that the repairs on any one street follow any definite law or rule. By averaging a large number the irregularities are eliminated. As an example, on one of our heavy traffic streets two adjacent contracts laid the same year by the same contractor show as follows:

Laid 1889, guarantee expired 1894.

	"A." Average cost. Ct.	"B." Per sq. yd.-yr. Ct.
[illegible]	[illegible]	[illegible]
[illegible] to 1917	[illegible]	[illegible]

Why should two pavements which differed so in their early repair rates come to so near an equality in their later maintenance, and why should one show a lower rate at 28 years of age than as 21 years?

Another piece adjoining one of these, laid in 1891, shows to 1910 a cost of 1.[illegible] ct. and 1911 to 1917 1.73 ct. per yard-year which is more consistent but abnormally low. Yet these pavements with present repair rates, at the end of nearly 30 years, running at about 5 ct. per yard-year, are worn so thin that patching is difficult and "humpy," making repaving desirable.

The above simple rule is fairly consistent with actual practice. It has the merit of being readily understood by the layman who has to stand part of the expense of repaving.

If a real "mathematical" rule is desired it is suggested:

$$\frac{\text{Cost of top} + \text{cost of repairs}}{\text{Age of pavement}} + \text{Study of record}$$

of previous repairs plus intelligent inspection of present condition plus requirements of traffic, equals a fair determination of "When to Repave."

GEO. H. NORTON,
City Engineer.

Buffalo, N. Y.

Finishing Methods for Concrete Pavements for Alleys

The Bureau of Street Construction and Repairs of Milwaukee, Wis., is obtaining good results in concrete alley paving by working dry mixture in the surface and thorough floating. The concrete in the pavement is a 1-2-3 mix; it is placed 6 in. thick. Expansion joints are placed not more than 25 ft. apart, and ½ in. elastite expansion joint fillers are used. The finishing clause in the specifications is as follows:

> After the concrete is deposited and brought to the proper contour, it shall be immediately gone over at least twice with a float [illegible] by 12 in., made of 2 in. oak plank and carrying an [illegible] handle. Immediately following this, a dry mixture, 1 part cement and 1 part clean, sharp sand that has passed No. 8 screen, shall be evenly applied over the entire surface, in sufficient quantity to absorb all water. In no case shall the quantity of the dry mixture be less than at the rate of 1 sack of cement to 30 [illegible]. The cement and sand must not be mixed more than 30 minutes in advance of its use, and shall be mixed by a man other than one of the floaters. After placing the dry mixture the floating shall continue until it is thoroughly incorporated [illegible] flushed to the surface. Sub[illegible] of about 5 minutes until [illegible] less than 3 times after [illegible] shall float continuously, [illegible] to each 200 yd. of [illegible] mortar shall have [illegible] and is slightly [illegible]

Road Design and Regulation of Traffic

By H. J. FIXMER,

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The subject of road design and proper regulation of traffic is both interesting and important. I shall attempt to discuss the principles to be considered and established before any rational progress can be made. The design, construction, regulation and even financing of roads is similar to railway construction and operation. It is the writer's opinion that practice in these matters should be intelligent and uniform in order to promote the development and free use of the road. Road building, from the modern point of view, is in the early stages of organization. The advent, or rather the development of the self-propelled truck has rendered custom, tradition and even past experience of little value.

In order to design a road economically and wisely there are three fundamental factors that must be known, established or at least intelligently assumed. These are: the proper width of roadway to safely accommodate the traffic; the structural efficiency of the road structure (including the sub-grade, foundation and wearing surface) and the proper regulation of the vehicles composing the traffic using the road in question.

Width of Roadway.—First, the width of the roadway must be determined. The width is dependent upon the amount of traffic, the width of the vehicles, speed of vehicles and provision for "parking" or standing vehicles. The amount of traffic is determined by a traffic census, a liberal analysis of the traffic likely to be attracted by the improvement, and a careful prophecy of future increase. It is usually expressed in terms of maximum number of vehicles per hour. The number of lines of traffic to be provided for is determined by the speed and headway (for safety) of the class of vehicles to use the road. On city streets it is often necessary to provide, in addition to the lines of moving traffic, for one or two lines of standing or "parking" vehicles.

The width and speed of the vehicle must be regulated. Table I indicates an approximate relation between width of roadway, width of vehicle and permissable speed of vehicle.

From Table I it is evident that the width of roadway should ordinarily be a multiple of ten, depending upon the number of lines of traffic to be provided for. If one or more lines of traffic are standing traffic the width may be reduced as indicated in Table I. Thus on a business street it is customary to provide for two lines of standing traffic and at least two lines of moving traffic. The width in this case would be 2 × 10 plus 2 × 9 (maximum width vehicle) = 38 ft. To provide for a third line of moving traffic the roadway would be increased to 48 ft.

To secure safety, and thus recognize the right of public use, the speed of vehicles of 6½ ft. in width should be limited to 25 miles per hour, of 7 ft. in width to 20 mlies per hour, of 7½ ft in width to 15 miles per hour, and of 8 ft. in width to 10 miles per hour. Eight feet in width should be the maximum width of vehicle allowed, except by special or emergency permit. An approximate method of estimating adequate roadway widths, based on average speed and number of vehicles to be provided for, is shown in Fig. 1. This diagram is based on average conditions for clearance and headway. A single roadway should not be permitted where the average speed exceeds 5 miles per hour and number of vehicles exceeds 50 per hour, unless the traffic is restricted to one way only. The number of vehicles per day (24 hours) is assumed to equal 10 times the maximum number per hour.

The method of using the diagram is as follows:

After deciding on the number of vehicles per hour to be provided for, follow up on the vertical line above the given

TABLE I—RELATION BETWEEN ROADWAY WIDTH AND WIDTH OF SELF-PROPELLED VEHICLES.

	Width of Vehicles					
Permissable Speed of Vehicles.	Ft. 6	Ft. 6½	Ft. 7	Ft. 7½	Ft. 8	Ft. *8½
	Width of roadway required per line of vehicle traffic.					
Parked or standing	7	7½	8	8½	9	9½
5 miles per hour	7½	8	8½	9	9½	10
10 miles per hour	8	8½	9	9½	10	
15 miles per hour	8½	9	9½	10		
20 miles per hour	9	9½	10			
25 miles per hour	9½	10				
30 miles per hour	10					

*City of Chicago—Max. width = 8½ ft. Max. length = 40 ft.

number to the intersection of the dash line denoting average speed in miles per hour. Continue up on the vertical line to the first heavy horizontal line which shows number of lines of moving traffic required. The width of roadway is given to the left on the continuation of this horizontal line.

If provision must be made for standing vehicles add the width as given in Table I for type of standing vehicle to be provided for. Thus for 2,400 vehicles per hour of average speed of 10 miles the diagram indicates 5 or a roadway of 50 ft. For standing vehicles (one line of each side of street) take widest truck (Table I) = 9 × 2 = 18. Thus the total width of roadway would be 50 + 18 = 68 ft.

This diagram may be used to determine congestion on a street and how it may be relieved by regulating traffic. For example: A 50-ft. roadway will accommodate only 1,600 vehicles per hour at the horse-drawn average speed of 2 miles per hour. Were this traffic routed on another street or speeded up to an average of 5 miles per hour, the capacity would be increased to 2,260 vehicles per hour, etc.

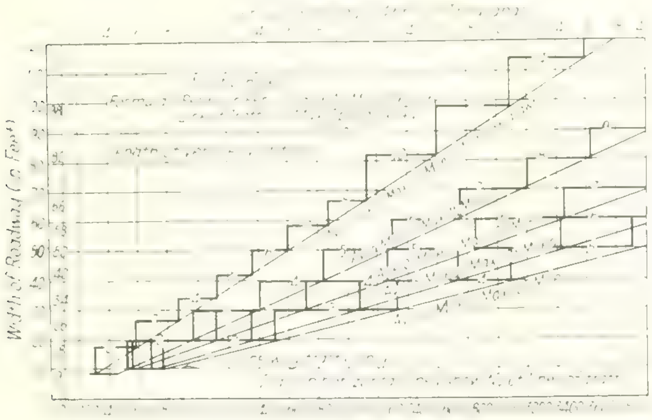


Fig. 1—Diagram for Design of Roadway Width.

MAXIMUM NUMBER OF VEHICLES PER HOUR

Note—All horse drawn use Av. = 2 miles. All truck drawn use Av. = 10 miles. Mixed horse and auto use Av. = 5 miles. All auto (mixed) use Av. = 15 miles. All passenger auto use Av. = 20 miles.

Note—Width is taken as necessary width for moving traffic. Where standing traffic is considered, width of roadway may be reduced as per Table I.

The distance required to stop a car equipped with proper brakes, road in average condition, and driver alert, is determined by the following formulas:

$$\text{Distance (in feet)} = \frac{(\text{speed in miles per hour})^2}{10} \qquad \text{(Formula 1)}$$

The headway required for fast moving vehicles varies with the maximum speed of the vehicles, the factor of safety assumed (to allow for poor brakes, time for driver to act, etc.), and the length of the vehicles in service.

$$\text{Headway (in feet)} = D \times F + V \qquad \text{(Formula 2)}$$

Where D = distance required to stop as determined by Formula 1.

F = factor of safety. F is taken to equal 2 in Fig. 1.

V = length of vehicles. V is assumed to vary from 15 to 10 ft. V is important only at low speeds.

The maximum number of vehicles per hour per line of traffic is estimated from Formula 3.

$$\text{Maximum number of vehicles per hour per line of traffic} = \frac{5{,}280 \times \text{Average Miles per hour}}{\text{Headway.}} \qquad \text{(Formula 3)}$$

TABLE II

Assumed average speed.	Assumed maximum speed.	Formula.	Number of vehicles per hour per line of traffic.
2	10	$\frac{5280 \times 2}{10 \times 2 + 15}$	[illegible]
5	15	$\frac{5280 \times 5}{22.5 \times 2 + 15}$	440
10	20	$\frac{5280 \times 10}{40 \times 2 + 12}$	575
15	[illegible]	5280 × 15 / [illegible]	685
20	[illegible]	$\frac{5280 \times 20}{62.5 \times 2 + 10}$	780
25	30	$\frac{5280 \times 25}{90 \times 2 + 10}$	[illegible]

Assumed maximum speed is arbitrarily taken to fit character of traffic having an assumed average speed.

Except for passing, 25 miles per hour appears to be the economical speed from the standpoint of providing an adequate roadway and safety in operation. The greatest capacity is secured when the speed is uniform or average speed approaches the maximum speed. Formula 3 may be used in regulating speed where the capacity of the road is exceeded.

Road Structure.—Second: The structural efficiency of the road and roadbed construction must be determined. The road structure, comprising the base and wearing surface, is considered to act as a structural unit. The function of the road structure is to resist the wear and strain imposed by the traffic and to transmit the resultant pressure over an area of sub-grade capable of supporting such loads. While considerable experimenting, scientifically directed, must be had before design of structure can be said to rest on any but an empirical basis, this lack of data should not deter us from approaching a solution in a rational manner.

To design a proper road structure three factors must be known or intelligently assumed. These are: the allowable pressure the sub-grade can safely support; the structural resistance or strength of the road structure, and the amount and character of the imposed loads.

The first two factors are determined by engineering investigation or experience. The fixing of the third factor, namely, amount and character of the imposed loads, is uncertain. It is now recognized that this factor must be regulated by law. The allowable pressure on the sub-grade can be determined by experiment locally applied, or carefully assumed in the light of experience. It will vary, as a rule, from ¼ to 2 tons per square foot. To resist a given load the road structure and sub-grade may conveniently be considered to act as a unit.

Thus, where the bearing power of the sub-grade is not uniform, one of two things must be done. The sub-grade must be strengthened by drainage or construction of a sub-base, or the road structure must be of stronger section at the area of weakness in the sub-grade. Where the sub-grade is not uniform and no effort is made to bring all weak areas to the adopted or assumed standard, it is not economical to specify a constant or uniform section of road structure. Where it is impractical to determine weak areas until the road is under construction, or where it is deemed more economical to increase the strength of the road structure, a uniform thickness or composition of road base should not be specified, but bids taken on the basis of cubic yards of material in place, rather than the customary item of square yards of pavement surface. The diagram (Fig. 2) shows an approximate method of proportioning road bases to withstand an assumed wheel load on sub-grades of various bearing power. This diagram must be regarded as educational rather than as an exact solution of an engineering problem.

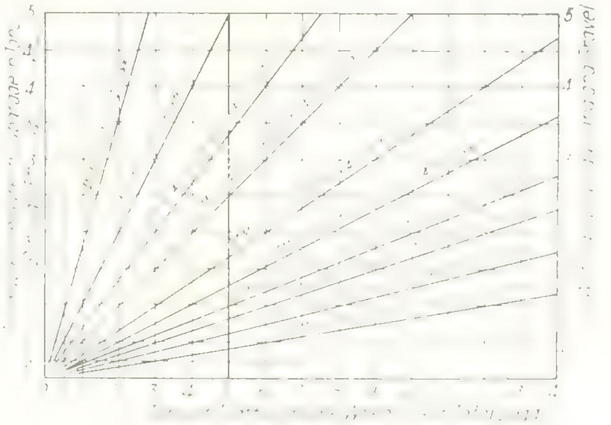


Fig. 2.—Diagram for Design of Permanent Foundations.

Note—Wearing surface not included as part of foundation, except monolithic brick, which may be considered equal to concrete base 1 in. less in depth. A concrete pavement without wearing surface shall be considered equal to the same base but 1 in. less in depth (thickness).

Were the maximum allowable load on one wheel fixed at, say 5 tons, and the speed restricted as outlined in a subsequent paragraph, the thickness of pavement bases could be fairly determined for various sub-grades. Thus, where the wearing surface adds no strength to the base, the thickness [illegible] approximately as [illegible] Fig. 1.

Regulation of Traffic and Load Stresses.—Third. The amount and character of the load or stress imposed must be assumed [illegible]. The regulation of the vehicles using the public highway is necessary in order to promote public safety, protect road structures, and to attain a satisfactory and harmonious development of road building, truck [illegible] service. Strictly speaking, it is not possible at this time to strike an economic balance between the maximum size load and the economic limit of road structure to accommodate such traffic.

It is evident that a road structure designed to support all possible loads is not economic, and since it is based on mere prophecy, is wasteful and of uncertain life. If we digress to the situation of the railways we find that they have definitely established the width and height of their rolling stock. They have found it necessary to limit and distribute the weight of their heaviest locomotives and cars, because of the weakness of their road or railway, and its support. [illegible] are being made where the volume of traffic warrants, in designing a more substantial roadbed. But this is limited to special lines where business and traffic is permanently established and its justification is determined by cold economic analysis.

It appears, at this time, to be the general consensus of opinion that the truck known commercially as the 5 to 7-ton truck is the maximum size which it is economical to operate in general service. This truck weighs from 6½ to 7½ tons without load. When loaded the weight is less than 15 tons. Since the rear axle carries approximately two-thirds of the load, there would be a trifle less than 5 tons on one rear wheel. It is the writer's opinion that a maximum load of 5 tons on any one wheel should be the established limit.

The factors to be considered in determining the wear and stress of wheel loads on a pavement are: the maximum load on one wheel, the diameter of the wheel, width of tire, kind of tire, kind of springs, smoothness of pavement surface, and speed of the vehicle.

The maximum load on one wheel should be limited to 5 tons. This loading, while apparently arbitrary, is reasonable, because of a combination of mechanical limitations which sense this limit as the proper one. The old ordinance of the city of Chicago allows 1,000 lb. per inch in width of tire; a total gross load of 15 tons, and a maximum of 6 tons on one rear wheel.

The width of the tire, if rubber, is limited by the strength of the rubber structure, which has been experimentally determined to be about 800 lb. per inch in width. The mechanical structure of the wheel and effect of power stress also tend to limit the width of tire. A loading of 800 lb. per inch width of tire, when applied through a resilient tire, can be safely carried by a road structure up to a reasonable limit. The necessary width of rubber tire (in inches) is assumed to equal the tons on one wheel multiplied by 2 5/10. (Formula 4.) Because of the less area of contact with the road surface, and effect of greater impact, a steel tire must be wider than a rubber tire for a given load. The necessary width of steel tire (in inches) is assumed to be equal to the tons on one wheel multiplied by 4. (Formula 5.) The diameter of the wheel, efficiency of the springs and the smoothness of the pavement surface may be neglected temporarily, since the diameter of wheels varies but little, and the effect of springs and smoothness of pavement surface are of little consequence where the pavement is properly built and maintained.

The matter of allowable speed is, however, highly important. This must be regulated because of public safety, effect on wearing surface and pavement structure, and effect in determining roadway widths. As the speed increases, more clearance must be provided, as shown by Table I and Fig. 1. The permissible speed should be defined and enforced, taking into consideration such factors as width of roadway, width of vehicle, weight of load, kind and width of tire, and character of roadway or thoroughfare. Were the permissible speed for vehicles of excessive width reduced as shown on Table I, the suggested limit of 8 ft. in width for vehicles would become recognized as an economic limit. Likewise the height should be limited to 12 ft. on account of bridge or subway clearance, and the overall length to 24 ft. because [illegible]. Adequate width or roadway must be provided or the speed reduced as indicated in Table I. Taking the passenger automobile as the basis, the speed should be limited by consideration of public safety to from 10 to 30 miles per hour. The locations where these limits would be imposed would range from a business street to the wide through route or unfrequented country road. The speed of trucks should be reduced, depending upon the load carried, as indicated in the following formula:

$$S = \frac{P \times (9 - W)}{10} \qquad \text{(Formula 6)}$$

Where, S = permissible speed for trucks in miles per hour.

P = established permissible speed for passenger autos in miles per hour.

W = weight of load in tons on one wheel.

The above formula applies where vehicles are equipped with rubber tires. When steel tires are used, as with trailers, then,

$$S = \frac{P \times (9 - W)}{1\text{[illegible]}} \qquad \text{(Formula 7)}$$

The character of the highway should be the principal basis for establishing the maximum speed permissible for passenger automobiles. The speed for typical locations might be adopted as shown in Table III, provided the roadway is of ample width. (See Table I.) These limits should be properly posted at all changes in the character of the highway, and effectively enforced. Proper enforcement will require adequate policing on all main highways, both within and without town or city corporate limits.

The "center traffic" is the usual fast traffic using the middle area of the roadway. The "side traffic" is the slower traffic usually traveling along the side of the roadway. The "passing speed" refers to the emergency increase of speed allowed to pass the slower moving traffic. It will be noted by referring to Tables I and III that the maximum speed allowed on public thoroughfares is 30 miles per hour. The speed of trucks or heavy loaded vehicles is to be reduced for the typical location shown on Table III as indicated in Formulas 6 and 7. To assist in enforcing speed regulation, all trucks should be required to carry a sign with the speed ratio for the given truck. Thus the ratio for a truck having 4 tons on one wheel would be "($\frac{5}{10}$)." (Formula 6.)

Design of Road Structure.—From the preceding discussion the manner of determining the width and the stress the roadway must bear is indicated. The regulation of traffic is emphasized, and the reasons for restrictions as to width and kind of tires, maximum loading, and speed of vehicles on public roadways are briefly outlined. There remains an investigation as to the most economic materials and manner of road construction to meet the demands of the traffic which the road in question must accommodate. Having definite conditions established it is the province of the road engineer to design a suitable structure. The principles of structural design will not be discussed at this time. (See Fig. 2.) The road should be designed to fit traffic conditions and not to meet arbitrary financial limitations.

Unfortunately a great number of bond issues and appropriations for road aid are made on the basis of building a definite number of miles of road. This is illogical and will be a constant source of friction or disappointment. Roads must be designed up to a standard and not down to a price, particularly when the basis of cost ignores the fundamental elements of traffic needs. Improvement in practice has been rapid the past few years, and it can be stated with confidence that the experienced road or paving engineer, with proper regulations in force, can design a road structure to meet the given traffic need as well as provide a surface that will economically satisfy the desirable features of low cost, low cost

Table III.—PERMISSIBLE SPEED OF PASSENGER AUTOMOBILES.

Class of Thoroughfare	Permissible speed in mile per hour.*		
	Center traffic.	Side traffic.	Maximum or passing speed.
Through routes (3 or more lines of traffic)	30	20	30
Boulevards and country roads	25	20	30
Village streets and narrow roads	20	15	25
City streets (residence)	20	15	25
City streets (business)	15	10	20
City streets (heavy traffic)	10	7	15

*State of Illinois—10 to 25 miles per hour.

of repairs and maintenance, safe traction, durability and general acceptability.

Financing.—The method of financing the building and maintenance of roads and streets is an interesting problem. The funds for this purpose must come from three sources, namely: the user of the road, the abutting property owner, or the taxable public, as represented by a governmental unit. It is becoming the general practice to tax all vehicles (the user of the road), and employ the proceeds for road or street maintenance, repairs, reconstruction and even new construction. If the user of the road is to be taxed, the amount of the tax should be apportioned according to both the damage done or the wear occasioned, and volume or extent of use. The character or power of the vehicle and load capacity is the practical measure of potential wear or damage. The following formula has been developed to meet average conditions in determining a fair vehicle tax or fee:

$$\text{Registration Fee (in dollars)} = \frac{\text{Horsepower} \times \text{tons on one wheel*}}{2} \qquad \text{(Formula 8)}$$

*Minimum load assumed at one ton. Minimum fee at $5.00

To limit the tax to a uniform fee for a given class of vehicle is not equitable. The extent of damage or rather wear which any vehicle may be assumed to produce, would vary directly with the mileage of such vehicle. The application of a tax or charge on the amount of mileage could be done in several ways. One method would be to equip all vehicles with a tax-speedometer under seal, and to charge for the excess use or mileage as indicated in Formula 9.

$$\text{Users' Tax (in dollars)} = \frac{\text{Horsepower} \times \text{tons on one wheel} \times (\text{Total mileage} - 5{,}000)}{10{,}000} \qquad \text{(Formula 9)}$$

In this formula a vehicle having an annual mileage of less than 5,000 would not be taxed, in addition to the registration fee. These formulas are only tentative, but at least indicate a fair manner of apportioning the costs of road maintenance. The "user's tax" should be apportioned between the state and municipalities, on the basis of use of road or street.

Another method of taxing use of the road might be effected by adopting a tax on motor fuel, with a modification of rate to apply to vehicles of a more destructive tendency. This method has been used abroad, more to conserve fuel perhaps than as a basis for taxation.

The abutting property owner should pay some portion of the cost of new construction and even reconstruction where it can be shown that he derives a benefit either in service or enhancement of property values.

The general public, as represented by a governmental unit, should pay some portion of the cost of new construction, when the character of the improvement or its use is not entirely local.

The problem of distributing the proportionate share of the cost of road improvement among the three parties interested is determined by law, custom or expediency, rather than by a complete scientific study and analysis. Every improvement is a different proposition and the method of taxation must be carefully thought out.

In justifying an expenditure for road improvement in any given locality the engineer must be prepared to prove that the total annual loss occasioned by the use of the present unimproved road is more than the annual cost of an improved road, designed to meet the traffic needs of such locality.

To estimate the total annual loss to both the user and the community, by reason of suffering an unimproved road, is not difficult, although not readily reducible to formula.

In comparing wear, life and maintenance costs of all types of improved roads, it is often convenient to use the cost per ton-mile or vehicle mile, as a basis.

$$\text{Cost per ton-mile*} = \frac{\text{Total annual cost of road}}{\text{Total ton-miles*}} \qquad \text{(Formula 10)}$$

*Vehicle mile may be substituted for ton-mile

The annual cost of the road is the summation of interest on first cost, average cost of repairs and maintenance, and amount to amortize first cost at end of life of the road structure.

This third factor is the amount set aside each year in a sinking fund to meet the bond issue when it falls due or to accumulate in a fund to be used to reconstruct the pavement at the end of its life. It is evident that the term of a bond issue should not exceed the estimated life of the pavement.

There is another phase of road traffic that should be considered. The extensive use of auto trucks for local and through traffic has raised the question whether the public should pay the increased cost of providing this "industry" with adequate traffic ways over the cost of lighter construction adequate to the needs of ordinary use. In promoting the use of trucks and extolling their advantages over rail service, it is customary for truck owners and manufacturers to omit any charge for their proportion of the excess cost of road construction or road maintenance, other than to include the moderate annual vehicle tax. Railways include in their charges, both cost of road or rail construction and maintenance, and even cost of right of way.

Where the motor truck is competing with the railway as a common carrier, it is a debatable point whether the public should encourage a wide range of competition by subsidizing truck traffic to the extent of building abnormally strong road structures for their free use. It is the writer's opinion that the so-called "users' tax" should be applied to traffic using the road as a business.

If motor truck users expect to be provided with suitable road structures at public expense it seems reasonable that they should admit the public's right to regulate the character of the vehicle and its use. The public should have the right to tax this traffic sufficiently to cover the cost of excess maintenance, and excess cost of building a road structure to accommodate such traffic. When this is generally admitted, with proper regulations and adequate taxation adopted and enforced, roads can be adequately and economically designed as well as repaired and maintained in a highly efficient manner.

Simple Methods of Applying Bonus System for Motor Truck Drivers

There is no more conclusive argument in favor of bonus systems for motor truck drivers than the fact that this method of stimulating economy has proved successful to practically all the operators who have used it, states the Power Wagon. In planning the bonus system, the motor truck owner must instill into the mind of the driver that the vehicle he is operating is temporarily his own; that he has a pecuniary interest in getting the best service out of it. In other words, as the earning capacity of the machine increases, by reason of reduction in running costs, the driver must earn more money. The question is how this condition is best achieved. Some motor truck operators compile a table of operating costs for their power wagons and then offer their drivers a wage increase of $2 per week every six months, provided the operating cost has been kept within the definite limit set. This plan seems to work out well in actual practice, because during each six months' period the driver strives in every way to keep the operating cost low, so as not to lose his $2 per week increase. Many operatives have found it advantageous to handle the bonus on what may be called the percentage basis. In this case the operative with the cost sheet before him sets a definite average consumption for gasoline and oil, an average for repairs, an average for tire wear. Then he offers his driver a percentage of any saving he can affect in fuel, oil and tire bills. Say that the average for gasoline consumption is 1,000 gal. per month. If the driver can by care conserve his fuel so as to get the mileage from 950 gal., he will receive a percentage of the cost of 50 gal. of fuel, the amount to be saved of the fixed average. Let us examine tire costs under this system, a big item under any circumstances. Let us say that the average tire life is 4,500 miles. From this the owner can readily figure the cost per tire per 100 miles. If the driver can, by careful driving, increase the tire life by 500 miles he receives as a reward for his skill and care a certain percentage of the saving he has made. With this system in effect, the motor truck owner will be surprised to find that his drivers are looking over the tires carefully, cutting away cracks likely to destroy the tire, and that they are avoiding running in car tracks and doing the other things they know are bad for the tires, but which they will persist in doing unless it is made worth their while to avoid.

Convict Labor on State Highway Work in California

In 1915 the legislature of California enacted a law authorizing the employment of convicts on the construction and improvement of the state highway system. The act provides that the state department of engineering should supervise the road work and provide the necessary camps and commissary and that the prison directors should have control over the discipline and conduct of the men. Convicts employed on such work are granted additional good time allowance, not to exceed one day for each two calendar days they are away from the prison. Under this law work has been done on highways in Mendocino, Sierra, El Dorado and Calaveras Counties. Interesting information on this convict labor work is given in the recently issued first biennial report of the California Highway Commission. The matter following is taken from that report.

Convict Labor in Division 1, Mendocino County.

The first step in the experiment of working prison labor on state roads was taken when on Sept. 20, 1915, a camp of 47 convicts from San Quentin was established by the Highway Department in northern Mendocino County. This camp was shortly afterwards increased to 60 men and followed by the installation of another camp of 60 men. From time to time the capacity of the camps was extended, reaching the maximum in July, 1917, of 225 men.

The first section of road selected for construction by convict labor is 33.10 miles in length, extending from what is known as Rattlesnake Summit, a point on the old overland road to Eureka, to the Mendocino-Humboldt County line. The camps were first located centrally, being situated 23 miles from the nearest coast port, Union Landing, the base of supplies during the major part of the construction of the road. The men were shipped from the prison to Fort Bragg, the nearest railroad station, 45 miles distant, and transported by motor trucks to the camps.

The construction progressed in either direction, until in the course of time the camps became separate units, and as the work progressed to the north and to the south, more accessible bases of supplies were reached and the transportation problem became easier.

Upon the completion of the work described above, the convict labor was extended from Rattlesnake Summitt to Arnold, a station on the Northwestern Pacific R. R., distant 24.53 miles. It is anticipated that the construction planned will occupy the season of 1919, when 57.53 miles will have been constructed by convict labor.

Preliminary Construction.—A vast amount of preliminary work was necessary before the actual construction of the road could be prosecuted, including the reconstruction of an abandoned road from the coast to the camp sites, distant 15 miles; the erection of footbridges (wire suspension) and temporary wagon bridges at several crossings of the South Fork of the Eel River; the installation of 45 miles of telephone line, together with the construction of pack trails for the transportation of supplies and the moving of camps in advance of the construction of the road. Inasmuch as the camps were inaccessible during the winter months owing to the impassable condition of the roads and the entire absence of bridges on the Eel River, the transportation of supplies for the year had to be accomplished during the summer season, thus requiring motor truck service and, therefore, side roads of substantial construction. The transportation difficulties encountered and the inacessibility of the country may be better judged when it is explained that the crossings of the canyons involved the erection of nine bridges of from 130 ft. to 300 ft. in length, some of them being from 130 ft. to 150 ft. in height, and the grading of the road was accomplished in advance of the construction of the bridges. Naturally such obstacles created the necessity of transportation of construction supplies and equipment and food supplies by roundabout detours. The transportation difficulties were further aggravated by the frequent suspension of steamboat transportation to the bases of supplies on the coast for long periods, thus necessitating almost prohibitive hauls from distant points. It is needless to say that such conditions were not only trials at times to the conduct of the camps, but the source of much added expense to the cost of the work, and consequently a severe test of the first experiment with convict labor in California.

The permanent work accomplished to November, 1918, consists of the clearing, grubbing and grading of 36½ miles of road together with the installation of pipe and concrete culverts and retaining walls. Twenty-seven miles of road are from 16 to 18 ft. in width and 9 miles from 12 to 14 ft. The work also involved the maintenance of the road during its construction, which extended over a period of three years and included the removal of thousands of yards and slides; also the maintenance of the side roads used for the transportation of supplies and men, all of which is included in the analysis of the cost of the construction of the road.

Organization.—The Highway Commission is represented at each camp by a superintendent, who has full charge of the work, assisted by two or more foremen. A resident engineer is engaged to lay out the work and, with the assistance of a commissary clerk, orders and disburses the supplies to the cookhouse and to the men.

The prison authorities are represented by a head guard, who, with two or more subguards, controlled the discipline and conduct of the men.

The men were not guarded and the guards were not armed, there being no firearms in evidence either in the camps or on the work.

A camp physician was constantly in attendance at the camps and a dentist was engaged as the occasions demand.

The day's work consisted of eight hours on the grade, Sundays and holidays excepted.

The men are housed in tents and frame buildings. The camps are well lighted and heated. The sanitation conforms to the regulations of the Commission of Immigration and Housing, which covers everything conducive to cleanliness, health and comfort, including bathing facilities.

The food is wholesome and plentiful, the "convict ration" not being at all in evidence. The cooks are selected from the convict labor and the services satisfactory.

Method of Construction.—The work is being accomplished by means of pick and shovel and station cars, wheelbarrows, steam shovel, teams and scrapers and road graders operated by tractors, convict labor being employed in all methods with the exception of the operating crew on the steam shovel. The drilling is accomplished by both hand labor and machine drills. Throughout the entire construction more or less rock has been encountered and drill and powder have been an important factor in the prosecution of the work. The blasting operations have been extremely hazardous, involving the use of 250 tons of powder, and the men have displayed a remarkable aptitude for this class of work, both in caution and efficiency. Only one accident has occurred, for which no one was to blame; unfortunately, this accident proved fatal.

Conduct of the Camps.—The honor system is employed, the men being unguarded at all times, and it may be said the men have as a rule readily responded to the honor system; this, in the face of the diversified personnel of the camp, which comprises men serving sentences from a few months to life, and for crimes ranging from petty larceny to murder, men of all nationalities, from all grades of society and of all trades and professions.

The behavior of the men, both on the work and in camps, and their efficiency on the work, compares favorably with free labor camps, and the exceptions are as few. As a rule a spirit of cheerfulness and contentment prevails; however, occasionally the sense of freedom is irresistible, although the percentage of escapes is small. Undesirable characters, such as malcontents, shirkers, etc., are promptly returned to the prison.

The following is an analysis of costs:

		Cost per man day.
Guards		$0.120
Transportation		.191
Clothing		.267
Subsistence		.930
Housing		.130
Escapes		.031
Medical		.053
Tobacco		.048
		$1.870
Cost per effective man day		2.530
Total number of man days	162,458	
Total number of men shipped to camps	770	
Number of escapes (27 captured)	38	

The cost per effective man day is arrived at by the application of the cost per man day of the percentage of time not employed on the actual construction, which includes time for men employed about camp, lost time on Sundays, holidays and on account of sickness.

The work accomplished is as follows:

Excavation —	
Solid and loose rock	111,125 cu. yd.
Earth and clay	336,375 cu. yd.
Total	747,500 cu. yd.
Excavation per man day	4 cu. yd.
Average cost per cubic yard, $0.669	
EXPENDITURES	
Excavation, including clearing and grubbing	$500,077.10
Culverts, retaining walls, etc.	50,150.00
Total expenditure by convict labor	$550,227.10
Total miles of road construction	36.5
Cost per mile	$15,074.70

The expenditures for excavation, culverts, retaining walls, etc., include overhead and engineering, preliminary work and all else incidental to the construction of the road. The bridges were constructed by free labor and their cost is not included in the foregoing statement of cotss.

Conclusions.—The efficiency of the system of dual authority as prescribed by the convict labor law is problematical, the serving of two masters successfully being one of the unsolved problems in all walks of life, and this phase of the organization is one that merits serious consideration in the future enactment of laws relating to convict labor.

The analysis of costs shows an effective cost per man day nearly equal to the laborer's wage during normal times: a logical mathematical conclusion for the reason that ordinarily the free laborer simply ekes out a livelihood from the going wages in normal times and the convict laborer is given even a greater share of the necessities of life. However, in all labor camps there is a certain percentage of skilled labor demanding a higher wage, thus affording a margin offsetting in a more or less degree the difference of efficiency, if any, as compared with free labor. The comparison in efficiency is affected by the times and the labor market.

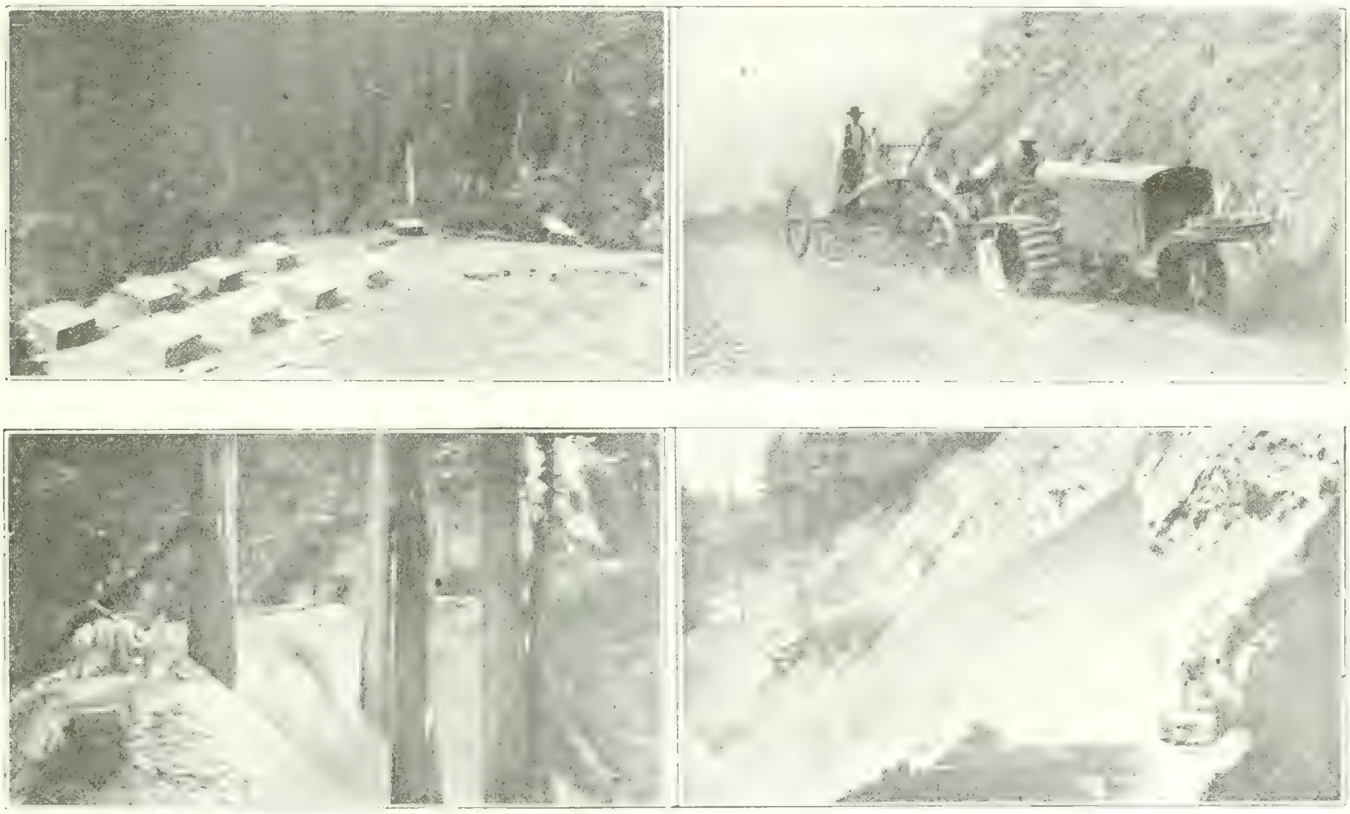
The prison labor has during the "work or fight" period constructed an important link of the California state highway through an exceptionally rugged and remote country and under severe climatic conditions, as the work was continuous through three winter seasons of heavy rainfall. The results from both humanitarian and economic standpoints may be considered as being satisfactory, and it can be said that the men from the California state prison at San Quentin have "done their bit toward winning the war."

Convict Road Work in Division II, Sierra County.—In July, 1916, a convict labor road camp was established in Yuba River Canyon, Sierra County, California. The work was heavy, running 8,500 cu. yd. per mile, mostly solid rock. Food and accommodations were excellent and conditions in general ideal, but results were very unsatisfactory at first.

The first nine months were spent in trying to work under a law which gave the prison authorities and the highway commission equal authority in the supervision of the convicts and their work.

"No man can serve two masters," much less a convict, and the project was a failure until March, 1917, when the prison authorities gave to the highway commission full control. Since that time the organization has been so perfected and the interest of the convict in the work so improved that we are doing the work now for one-half of what we would pay a contractor, or about 35 ct. per cubic yard for earth excavation and 50 to 60 ct. for rock excavation.

There are very few skilled laborers among the convicts on whom much dependence can be placed. It is, therefore, a problem of getting the most out of a lot of simple-minded laborers, the personnel of which changes rapidly. Machinery and other refinements must be introduced very slowly and to a limited extent only. Only simple methods and equipment are therefore used, such as powder, pick and shovel, the wheelbarrow, and cars with track, and the plow and scraper to a limited extent.



Upper Left View: First Convict Camp in Mendocino County (60-Man Camp). Upper Right View: Trimming Road with Tractor and Grader. Lower Left View: Making Fill on State Highway With Convict Labor. Lower Right View: Convict Work on State Highway.

The things most essential are complete control of the forces, full co-operation on the part of the prison authorities and a competent superintendent. There are very few men capable of handling convicts who are willing to take a position as superintendent and live with them. The position requires a young, big-hearted chap, full of energy, who can use tact and firmness and still be pleasant and respectful.

Another matter of great importance is the selection of convicts. There should be no short-termers, that is, those with not less than six months to serve, and they should, of course, all be healthy, able-bodied men. Some of the best men are life-termers and some good men are third and fourth termers, though they are long-termers. The short-term "repeater" is a weak, dissolute character, who is physically and mentally unfit for work.

At present (November, 1918) the camp contains about 100 convicts, four guards, four foremen, one superintendent, one [illegible] is really a fore-[illegible] drivers and a [illegible]

Guards are not used as foremen but for police duty only, [illegible] the men to such an [illegible] all, the guards [illegible] working.

[illegible] They do not understand road work. It is out of their line of business. Furthermore, [illegible] who are appointed by the prison authorities is recognizing the dual [illegible] organization and cause all kinds of trouble in camp.

The most economical and satisfactory housing is well-[illegible] and tar paper. Tents [illegible]

[illegible] ft. long and are heated by two large wood stoves in winter and ventilated by large screened windows, covered by shutters hinged on the upper edge.

Each man is provided with a steel spring cot, a cotton mattress and plenty of blankets and warm clothing, and he is required to keep himself and his clothing clean.

Shower baths are provided with plenty of hot water, and the convict is given all the good wholesome food he can eat and plenty of tobacco. He is better cared for than he would be in any free labor camp. Criticism has been made that we treated them too well but we know, by experience, that it pays to treat them well.

Between July, 1916, and December, 1917, the convict gang built 7.6 miles of road in the Yuba River Canyon at a cost of $11,340 per mile, or about $1.30 per cubic yard. This work [illegible]

Between [illegible], 1917, and November, 1918, another section of [illegible] at a cost of about $5,500 per mile, or about [illegible] per cubic yard. This work was mostly earth.

The roads are being built 12 ft. wide in excavation and 14 ft. [illegible] and all in a rough, rugged, mountainous [illegible] transportation of men and supplies is [illegible] and almost out of the question in winter. [illegible] supplies must be stored in camp by the [illegible] November to last until the middle of April.

[illegible] camp is a very efficient and money-saving institution. Comparing it with free labor, the convict [illegible] costs about $1.50, while free labor costs $4 per day and the convict will do more work than the average free laborer available at the present time.

Cost of Convict Labor Work. The cost of convict work day for the period of five weeks, ending Sept. 7, 1918, was as follows:

COST OF CONVICT WORKDAY.

Food	$0.632
Hauling	.049
Transportation	.056
[illegible]	.127
Guard maintenance	.023
Clothing Tobacco [illegible] [illegible]	.126
[illegible] of camp equipment	.030
Hauling of camp equipment	....
Miscellaneous	.010
Camp maintenance	.009
[illegible] food	.051
Total	$1.113

DISTRIBUTION CONVICT TIME.

Total convict workdays	2,444
Sundays and holidays	352
Sick days	126
Bad weather	....
Cook house days	224
Camp maintenance	58
General	11
Total convict days	3,215

$$\frac{1.113 \times 3215}{2444} = \$1.46$$

Cost of convict workday.

Convict Road Work in Division III, Calaveras and El Dorado Counties.—Two sections of state highway in Division III have been worked by convict labor during the years 1916, 1917 and 1918. The work on both sections has been under conditions not entirely suited to the use of convict labor, though such lack of success as there may have been is partly due to the restrictions and regulations under which such work has to be carried on under the California convict labor law.

The cost per convict working day has averaged approximately $1.50 for an aggregate of 44,000 days.

The first camp (an honor camp) was established in Calaveras county between Valley Springs and San Andreas, 100 miles from the prison at Folsom.

The work consisted of grading, graveling, concrete and corrugated pipe culverts and wooden guardrail. The section is 10 miles in length and was what might be called a light grading job as far as yardage is concerned. For a mile or more on each side of the Calaveras River some fairly heavy grading was encountered, the greater percentage being in rock.

Throughout the balance of the section, though the grading was light, a great deal of it was in rock where it was necessary to shoot and handle several times the amount of material shown by the cross sections.

In [illegible] per cent solid rock the grading cost was	$0.584 per cu. yd.
In [illegible] per cent earth, [illegible] per cent shale and solid rock cost was	0.384 per cu. yd.

The total expenditures on the section were $68,195. Of this amount $13,500 was spent in the construction of five concrete bridges for Calaveras county and $18,000 to $20,000 in graveling, dragging and maintaining. The grading, culverts and guardrail cost $35,000, or $3,500 per mile.

The adjoining section on the west, Cal-24-A, is now being graded by contract at a total cost of $53,853, or $5,574 per mile. The grading on this section is lighter and of easier construction than the section built by convict labor. While the condition of relatively light grading made it difficult to work convict labor to advantage, nevertheless the results secured were by no means unsatisfactory as compared with the probable cost had we used free labor throughout.

In El Dorado county, however, the experience has been different.

The Calaveras camp was an honor camp while the El Dorado camp, on the other hand, is an armed camp. The men are brought out each morning from the prison by trucks and taken back at night. The long distance traveled each way leaves an unsatisfactory number of hours on the work. The men are of an inferior grade and the use of convict labor in El Dorado county has been very unsatisfactory and extremely expensive, and its continuance was justified only on account of the shortage of free labor due to war conditions and also the fact that such free labor as has been available has been inefficient and high priced.

In order to work this kind of labor satisfactorily the camp should be an honor camp and there should be sufficient pick and shovel work to keep a large gang constantly busy, as this class of labor can certainly be worked to the best advantage when up against a bank.

The conditions under which convict labor has been employed in Division III have not been ideal for this class of labor and there has been no real opportunity to determine the efficiency of this class of labor.

Method of Preventing Grade Wash in Pot Holes

By L. U. MARTIN.

In our road work in this section of the state we frequently meet with pot holes of considerable depth which have a very small drainage area and which, owing to their depth, are not easily tiled or ditched out. As the country is composed of glacerial drift, vertical drainage through drainheads is not as a rule very successful. Roads have been frequently laid out across such pot holes and the grades built across them at times when they contained no water.

Two years ago we had an unusually heavy precipitation following a very heavy fall of winter snow which had drifted into these holes, in some cases filling them. As a result when the spring rains were over these grades were nearly covered with water. Waves caused by heavy winds began to wash them out. As we have no ledge rock, and to collect boulders for rip-rap is expensive and takes considerable time, a special method of saving these grades and keeping the road open to traffic was necessary. The plan finally adopted was as follows: An 8 or 12-ft. cedar post, depending on the depth of water, was driven out on the slope of the grade from a raft or boat until it was firm, then a string of 4, 6 or 8-ft. woven wire was stretched along these posts and fastened as well as possible. Between this and the grade flax straw, old hay, straw, or manure, was packed. This completely stopped the wash.

The Highways of the Future*

By H. G. SHIRLEY,

Secretary, Highway Industries Association.

In considering "The Highways for Tomorrow," we must not set small limits for them in our minds, for the picture, as I see it, is one of magnitude, beauty and great material and recreational value to all the people. For the sake of distinction, I have separated these highways under two heads; the "Imaginative" and the "Speculative," and have made a further separation into national, state and county highways.

The "Imaginative" road is a dream of what the roads of our country will be 10 or 20 years from today. The "Speculative" road is what we estimate they will be, basing our assumption on past experience and what has been accomplished, as a basis of calculation. National highways will be built and maintained by the federal government, the state highway by the state, and the county highway by the county. Furthermore, each group will be composed of three classes, such as Class A, B and C.

Class A, National Highways.—These will be the main trunk highways passing through a state, connecting up the main centers of population, and serving the most densely populated sections, where the greatest volume of traffic will be found. The volume of traffic on a Class A road will not be less than 2,500 tons per day. The width of the right-of-way will not be less than 100 ft. The surfacing will be less than 60 ft. wide, and will be of the most durable materials, and designed to carry a moving load of 20 tons; 12 tons being concentrated on the read axle of the vehicle.

All grade crossings of railways or trolley lines will be separated by overhead or undergrade crossings, and intersecting roads will have a clear vision, at all intersections, of 50 ft. or more. Large expenditures will be made to straighten alignments and in the reduction of grades. The surface will be smooth, giving the least amount of tractive resistance and vibration.

Curbs, gutters, inlets, catchbasins, and a complete subsurface storm-water drainage system will be provided. A sufficient width on either side of the roadbed will be set aside for the planting of trees and the laying of sidewalks, conduits, pipe lines and other surface or subsurface structures; also for buildings for public use, such as rest sheds and comfort stations.

All curves will have a vision of at least 400 ft., and the roadbed and surface around all curves will be elevated from the inner edge to the outer edge, the elevation being computed for the degree of curvature and for a speed of at least 35 miles per hour.

Great care will be taken in laying out and establishing a Class A road. Points of interest and of historical value will be marked with suitable tablets, or monuments, or other devices—the proper arrangement of trees and shrubbery being such as to make the layout most attractive. Care will be taken to have the slopes of the embankments and cuts planted in grass and other suitable foliage.

Direction signs of neat and attractive design will be erected at all intersecting roads. Signs giving the name of the city, town or village will be erected where the national road enters and leaves.

Class B, National Highway.—These will consist of those roads having a density of traffic of over 1,000 tons per day. They will have a right-of-way of at least 80 ft. in width and a surfacing of 40 ft. All drainage will be provided, and where necessary a subsurface and storm-water drainage system will be installed. The surface will be designed to carry the same loads as, and will be constructed of materials similar to those used in, the Class A highways. The treatment of the portion outside of the paved surface and shoulders will be of a rural character, trees being planted which will be both productive and ornamental.

This class of highway will serve sections of the country where the land is practically all under cultivation, where small towns and villages are not far apart, or where industries are established requiring considerable tonnage to be transported over the highway.

Class C, National Highway.—This class will be where the traffic does not exceed 1,000 tons per day. It will have a right-of-way of not less than 60 ft. in width and a surfacing of 20 ft., designed for the same loading as Classes A and B.

This class of road will run through sparsely settled sections of the country, tying into Class B highways, and be the artery that will serve remote and densely populated sections of our country. It will make easy and convenient communication among all the people, inducing social intercourse and thereby making us all one great family.

Treatment of the right-of-way of this class will disturb its natural beauty as little as possible, but all means will be taken to bring it out with greater prominence. All historical points will be marked with attractive monuments and tablets. At points where there is beautiful scenery, parking spaces will be provided, and observation and shelter sheds erected. Vistas through the trees will be cut at points of vantage, and where beautiful scenery can be opened up. Shelter sheds and lodging shelters will be erected at convenient intervals, and telephones will be installed.

Structures on National Highways.—Snow fences or breaks will be constructed on all highways at all points where the snow drifts, relieving as much as possible the necessity of snow removal. With such places protected, snow plows and shovels, operated by tractors and trucks, will keep the roadway free of snow and open to traffic at all times. Where there are heavy falls of snow, the maintenance department will be fully equipped with all necessary equipment and organization to remove the snow quickly after each snowfall. The width of road that will be cleared of snow will depend on the volume of traffic passing over the highway, but under all conditions at least 16 ft. will be cleared.

On Class A national highways, where curbs and gutters have been constructed, no guard rail will be required, except on the outer edge of the sidewalk along embankments to protect pedestrians, and it will be of shrubbery hedges. On Class B national highways, at points where necessary, guard rail of neat design and permanent nature will be erected. Guard rail for Class C national highways will depend on the availability and cost of materials. It will consist of all kinds of materials from concrete walls to large boulders or rustic fences.

Danger signs of standard design will be erected on all highways at approaches to all sharp curves, sudden breaks in a grade where the view is obstructed, and at other points where there are elements of danger. The signs will be equipped with a lighting device to illuminate them properly at night.

All bridges on Class A national highways will be at least 50 ft. between the curb lines, with a suitable space for sidewalks. All bridge floors will be of the solid type and designed, with the other portions of the structure, to carry a 20-ton truck on four wheels, the distance between axles being 10 ft., and with a concentrated wheel load of 6 tons. Close study will be made of each location, and a design selected that will fit in with the general landscape and be most pleasing to the eye. Bridges erected on Class B national highways will be designed for the same loading as on Class A, but will have a roadway width of 40 ft. Bridges on Class C national highways will be designed for the same loading as Classes A and B, but will only have a clear width of roadway of 30 ft.

Class A State Highways.—These will be the main arteries in the state, connecting up with the national highway system, or connecting large towns and cities which are not connected by the national system. They will be designed to carry traffic similar to Class A and B national highways and will have a right-of-way 60 ft. in width with a surfacing of 24 to 30 ft.

The treatment of right-of-way outside of the shoulders and gutters will be variable and according to the development of the country through which the roads pass. Spaces for telephone lines, conduits, water mains and other subsurface structures will be provided outside of the surfaced area, and a parking space will be set aside for trees. The general type of treatment of right-of-way will be similar to that of Class B national highways.

Class B State Highway.—This class of state highway will have a right-of-way of not less than 40 ft. width and will be surfaced for a width of 18 to 24 ft. Careful study will be made of the traffic and the possible future traffic over this class, so that an accurate estimate can be made of the future needs and the weight of loads that it will be called upon to carry. If the traffic study shows that it will be quite a long time before the road is called on to carry a great amount of traffic, or that the traffic will be of a type that would not

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*From paper presented before the Joint Highway Congress, Chicago.

[illegible] will be designed for a [illegible] concentration of five [illegible] load should be allowed [illegible] permission.

Class C State Highways.—[illegible] through sparsely settled sections of the state and will tie into Class B roads, making a connected system. The width of right-of-way will [illegible] not less than 18 ft. The surfacing will run from a sand-clay or top-soil road up to [illegible] availability of materials and climatic conditions.

County Highways of the Future.—County highways will be exceedingly variable in the types that will be used, depending on the intensity of traffic. They will range anywhere from the highest type of national highway down to the earth road, which will constitute the greater number of miles in this system. The same markings and care of right-of-way will be taken that will be taken with the same class of state highway.

The earth road will be widened out, the right-of-way cleared for its full width, and the road kept well shaped up and dragged constantly. Much service can be secured from the earth road by properly maintaining the same, and very much greater care and attention will be given to this class of road in the future than have been given in the past. It will necessarily contain the largest mileage of all the types of roads for many years to come. In the past it has been shamefully neglected and abused, no attempt being made to make it give that service which it is capable of performing for at least 9 to 12 months during the year, depending upon the severity of the climate and the locality.

The above are classes of roads that the speaker imagines and believes will be in universal use in the next 15 to 20 years in this country, and are therefore classified under the heading of "Imaginative" roads.

The "Speculative" Road.—Under this heading we will have to make a close study of what has been done in the past to see what we may expect in the future and what the "Speculative" road of tomorrow will be.

It was about 100 years ago that the national Government and a number of the states started a road-building program. The Government built a few hundred miles of road and the states a similar amount. Shortly after the starting of this road program, all road building on the part of the national Government and the states ceased. The work was then taken up by many turnpike companies, which were formed and which built a number of roads in the Eastern states, operating them under the toll system. After the establishment of the toll road there was quite a long period of quietude in road construction. It was handled principally by the township and county officials, with no development in types of construction, or methods of maintenance, outside of the large cities. This condition continued to the late nineties, or practically to 1900, when the states, due to the change in the vehicular traffic passing over the road, saw the coming need of more and better highways, and began to make a study of the problem.

The study has been going on for 18 years, and, granting some progress has been made, there is by far a greater demand for more and better highways today than ever before. Why is this demand so great? It is because we have not kept pace with the requirements and needs of traffic and the development of the country. Therefore, if we should attempt to plan a system of highways, taking the progress of the past 50 years as a basis of calculation, we would fall far below the requirements of the future.

One hundred years ago the national Government laid out the right-of-way for its highways 66 ft. in width and constructed the surfacing from 20 to 30 ft. wide and of considerable depth, yet today we see the main state highway trunk lines and the Federal-aid roads being surfaced from 14 to 18 ft. in width, with a right-of-way in many instances not exceeding 30 ft. and a thickness of surface incapable of bearing the loads now passing over them at critical periods of the year—that is, when the ground is saturated with moisture.

All this is misleading for any basis of calculation and design to meet the future needs of the country's transportation. Let us now examine the mileage of roads constructed from 1909 to 1914, and see what progress has been made. From 1909 to 1914, a period of five years, there were constructed about 75,000 miles of roads, or so-called roads—that is, at the rate of 15,000 miles per year.

There are in this country today, under the headings of national highways, state highways, and county highways, with the exception of Class C county highways, about 500,000 miles of roads that should be improved, and their improvement will be a good investment for the people at large. Yet at the rate we have been going, and using the same character and means of construction, it would take 33 years to complete this mileage. If we constructed this mileage of highways to meet the traffic needs of today and the future, it would take at least 50 years at the rate of expenditure and progress that has heretofore been made. Therefore, any calculation or speculation we may make, using the mileage as heretofore constructed or what has been accomplished as a basis, would give such a small program of construction that it would be a very gloomy day for many of us who hope to see the building of roads put on a basis of keeping pace at least with the development of the country and the needs of transportation.

The development of the different types of surfacing is in its infancy, and much study, experimentation and development will be necessary. No field for the manufacturer of road material will offer greater possibilities. It is, however, most important that the highway engineer and the material interests work in closer harmony with each other, so that each type can be developed to the highest degree.

In laying out, constructing and maintaining the American highways for tomorrow, the highway engineer must not be bound by what has been done heretofore, or by any plan based on such accomplishments, but will have to rely to a great extent on his imagination, and picture the needs of and use to which the highways will be put in the future. As a note of warning, may I caution again that the limits of his imagination must not be small or restricted, but must be of wide vision?

Status of California State Highway Construction

The following tabulation from the first biennial report of the California Highway Commission shows the mileage of the several types of work accomplished in constructing the state highway system at the end of the fiscal year 1916, the accomplishment during the biennial period ending June 30, 1918, and the total mileage of each type on the latter date:

	June 30, 1916, miles.	1916-1918, miles.	Total June 30, 1918, miles.
Cement concrete base with Topeka mixture or sheet asphalt tops	17.01	20.81	37.82
Cement concrete base with thin bituminous tops	766.76	241.43	[1]1,008.19
Broken stone base with Topeka mixture top	16.21	......	16.21
Oiled macadam	129.38	50.91	[2]180.29
Bituminous concrete	10.37	8.76	[2]19.13
Graded, but not paved	323.14	32.62	[3]355.76
Totals	1,262.87	354.53	[3]1,617.40

[1] On approximately 480 miles of this type, the thin bituminous top has not been applied. [2] Includes 166 miles built by the counties, but now under the jurisdiction of the commission. [3] This figure does not include nearly 700 miles of graded road taken over August 1, 1917, from the State Engineer's jurisdiction.

The figures in the foregoing table do not include unaccepted contracts incomplete on June 30, 1918, at which time the following mileages of road were under contracts let and in progress:

	Miles.
Cement concrete base with Topeka mixture tops	2.18
Cement concrete base with thin bituminous tops	215.94
Graded but not paved	131.25
Total	349.37

A very considerable portion of the 349 miles was completed by June 30, 1918, probably not less than 60 per cent.

Snow Removal on Toronto-Hamilton Highway.—The cost of removing snow from the Toronto-Hamilton Highway for the winter of 1917-18 averaged $72.13 per mile. There were 10 days during the entire winter when it was impossible to get through from Toronto to Hamilton on the highway. Four ordinary road graders were used and proved quite satisfactory except in places where the depth of snow was not too great. Heavy drifts were shoveled by hand. The graders were left with farmers living along the road, and the arrangements had been made with them to supply teams and operate the machines whenever necessary. About 4 in. of snow were left in the road and this made excellent sleighing.

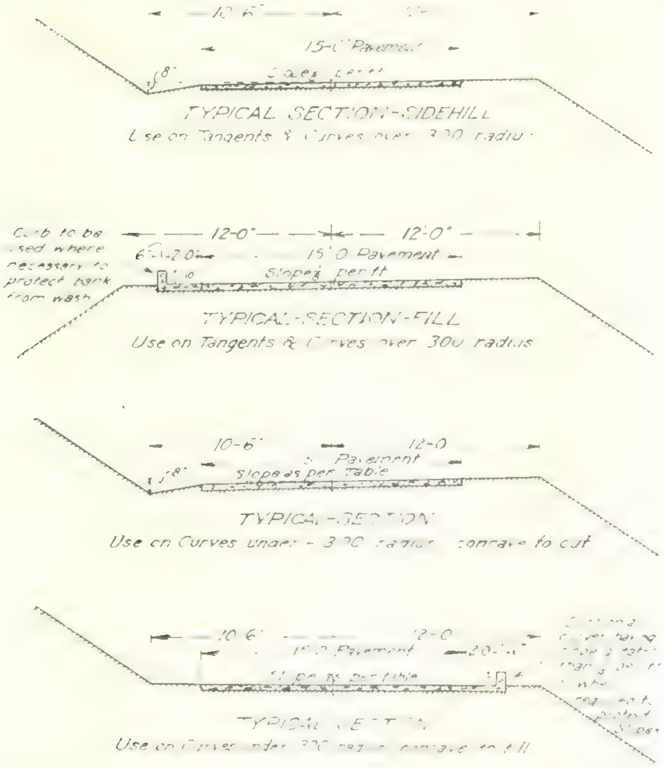
Concrete Pavements for Mountain Roads

The California Highway Commission has many miles of mountain roads, some paved and some unpaved, where side-slipping off the road means certain death to the occupants of the vehicles. The wooden guard-rails frequently erected at especially dangerous points are safeguards more imaginary than real in value. They warn the driver to keep away from the edge of the bank, but if a machine skids against the guard-rail, while the fence may retard the motion and often stop the machine, it should not be relied upon too much. In an effort to make the roads safer the commission in 1917 issued instructions to its division enigneers giving tentative sections for concrete pavements on mountain highways. These sections are shown in the illustration. The instructions include the following points:

While the sections show only 15-ft. pavements, with suitable modification, they will be used for greater or lesser widths when the approved plans so indicate.

On tangents and curves with radii over 300 ft., the pavement will slope downward toward the cut bank at the rate of ⅛ in. per foot, regardless of the direction of the curve.

Where a tangent has fill slopes on both sides, the slope will be downward toward the more suitable side for drainage.


10-6"
15-0" Pavement
8"
TYPICAL SECTION-SIDEHILL
Use on Tangents & Curves over 300 radius
Curb to be used where necessary to protect bank from wash
12-0"
12-0"
15'0 Pavement
Slope ⅛ per ft
10
TYPICAL-SECTION-FILL
Use on Tangents & Curves over 300 radius
10-6"
12-0
Pavement
8"
Slope as per Table
TYPICAL-SECTION
Use on Curves under 300 radius concave to cut
10-6"
12-0
15-0 Pavement
Slope as per table
TYPICAL SECTION
Use on Curves under 300 radius concave to fill

Typical Sections of California Highway Commission for Concrete Pavements on Mountain Roads.

Where a curve has fill slopes on both sides, the pavement inclination will be downward toward the concave side.

The pavement on curves with radii less than 300 ft. will slope downward toward concave side, the rates of slope being as follows:

For radii of 75 ft. or less, [illegible] in. per foot;
For radii of 75 ft. to 100 ft., ½ in. per foot;
For radii of 100 ft. to 150 ft., ⅜ in. per foot;
For radii of 150 ft. to 225 ft., ¼ in. per foot;
For radii of 225 ft. to 300 ft., ⅛ in. per foot.

A concrete curb, 6 in. wide on top with an exposed face 10 in. in height, will be placed at the outer edge on curves where the pavement inclines downward toward the fill slope at a rate in excess of ¼ in. to the foot. Curbs will not be placed on tangents nor on curves unless the slope of the pavement is greater than ¼ in. to the foot except where it is necessary to protect a fill slope from wash and then only upon specific authority from the highway engineer. Wherever curbs are installed suitable openings for drainage must be provided, together with proper protective devices against discharge through such openings.

Pavements having a normal width of less than 18 ft. will be widened 2 ft. on the concave side on curves of 150 ft. radius or less, the length of such crescent shaped widenings being limited by the natural "track" of the traffic. Two feet of extra width will be placed also at other points where curbs are installed on pavements less than 18 ft. wide.

The transition between curved sections and tangent sections will ordinarily be made in a length of 30 ft. one-half on the curve and one-half on the tangent, but the transition between reverse curves having pavement slopes of more than ¼ in. per foot may be made longer up to a maximum of 50 ft.

Tangents less than 100 ft. long connecting curves on which the slope is toward the fill will be considered exceptional cases and the pavement will slope toward the fill at the rate of ⅛ in. per foot.

These instructions are probably too conservative and it is likely that they will be succeeded by others providing for greater degree of superelevation. It has been found that roads built in accordance with these instructions offer no difficulty in driving and the driver has a feeling of safety which is absent on the center crowned road.

Thomas H. MacDonald, of Iowa, to Be in Charge of Highway Work for Department of Agriculture

Thomas H. MacDonald, chief engineer of the Iowa State Highway Commission, has been appointed by the secretary of agriculture as engineer in immediate charge of the work under the federal aid road act, which provides for co-operation between the states and the federal government in the construction and improvement of roads. Mr. MacDonald will assume his new duties as soon as he can close up his work in Iowa. In the meantime he will continue to keep in close touch with the federal aid road work of the department, as he has done during the past two or three months. Steps already have been taken to expedite the resumption and extension of highway construction under the terms of the federal law, as amended by the post office appropriation act, and nothing will be omitted to facilitate the vigorous prosecution of the work. The regulations have been carefully revised in the light of past experience and of suggestions offered by the state highway departments, the standards for plans, specifications and estimates have been modified to meet special conditions existing in some of the states, and other changes in practices and procedure have been made, all with the definite object of speeding up the work.

Mr. MacDonald will immediately supervise and direct all the activities of the Bureau of Public Roads under the federal aid road act, including the expenditure of the additional appropriation of $209,000,000 provided by the post office appropriation act for the extension and development of highway construction during the present and the next two fiscal years. For the time being, in the midst of the pressure incident to the resumption and extension of road work, Mr. MacDonald will devote his energies to problems arising under the federal aid road act. It is planned that, in the near future, he will formally assume the position of director of the Bureau of Public Roads, made vacant by the death of Logan Waller Page.

Mr. MacDonald was graduated from the Iowa State College in the civil engineering course and was employed by the Chicago, Great Western R. R. for a time on track work. In 1904 he became assistant professor of civil engineering at the Iowa State College and was placed in charge of road investigation work. In 1906 he was appointed highway engineer with the first highway commission in Iowa and held this position until 1913, when he was made chief engineer of the present state highway commission. He is also supervisor of state roads, having charge of all highways and streets adjoining or upon state farms, state institutions, and the state capitol at Des Moines. He is a member of the executive committee of the American Association of State Highway Officials. Mr. MacDonald's broad knowledge of and wide experience in highway construction matters peculiarly qualify him for the very important task of directing the activities of the federal government under the road act, in co-operation with the state highway commissions of the various states, and of supervising the expenditure of the large sums that are now available for this purpose.

Present Status of Brick Pavement Construction*

By Maj. Wm. M. Acheson.

[illegible] Engineer, New York State Highway Commission.

Brick pavement construction since 1915 has been subject to a greater [illegible] in design than any other pavement. [illegible] through a more rational use of the same amount of material have tended to greater strength and durability. In this paper it is the intention to describe the three different types of pavement, or I might say the old and the new methods, and point out the advantages and disadvantages of each.

Foundation Course.—The foundation course is usually made of cement concrete and in general a [illegible] and 1:3:6 mixture is specified, the thickness depending largely upon the character of the subsoil and the amount of traffic. While the cement concrete foundation predominates in brick pavement the construction of many miles has been laid on foundations of compact sand, gravel and broken stone. Engineers will agree with me in the absolute necessity and economy of concrete as a foundation for brick and all types of block wearing surfaces, together with mixed types of bituminous pavements. In fact, to my mind, the time is here when highway engineers are called upon to design rigid types of construction to meet the demand of modern traffic, which means the development of heavy motor driven traffic. Engineers are now giving special attention to the different parts of a pavement in order to meet existing conditions. Metal reinforcement is sometimes specified to be imbedded in the concrete foundation over soft places and recently dug trenches. By this it is hoped to prevent the cracking which in the majority of cases comes from the condition of the subsoil through the base to the surface of the pavement. Experience has shown that an evenly built foundation which conforms to the finished cross-section of the road, will result in a uniform thickness of sand cushion and a smooth wearing surface. In this pavement as in all other pavements the key to the whole situation is the condition of the subsoil and the foundation, and in this phase too great care cannot be exercised from the design or construction standpoint.

Sand Cushion.—Brick pavements with a sand cushion or a bed course of plain sand have been built since the first brick pavement constructed in 1870 and represent at the present time by far the larger percentage of the three types. The thickness of the sand cushion called for in the older specifications in constructing this type of pavement has been considerably greater than advocated by most engineers at the present time. The theory advanced in behalf of the sand cushion is that it serves the double purpose of providing a uniform bearing for the wearing surface and supplied resiliency under traffic. With this in mind specifications called for a sand bed not less than 2 in. in thickness, many of which were not given the proper care in constructing and were formed by screeding out the full thickness at one time without necessary consolidation by hand rolling. This was responsible for failures in the brick wearing surface which engineers traced directly to the non-uniformity of the sand bed. This was endeavored to be corrected in later specifications by calling for a sand cushion of not over 1 in. in thickness, together with requirements as to its gradation by sieve analysis and the amount of loan permissible in the sand used.

New York State specifications for the bed sand required a sand of which 100 per cent passes a No. 6 sieve and not over 90 per cent through a No. 20 sieve. "An excessively fine sand will not be accepted in this class. Sand may be rejected if it contains more than 15 per cent of loam and silt," which amount was deemed advisable for proper compacting.

Present-day specifications describe carefully the manner of forming or building up the sand bed by screeding it in layers and rolling in order to form as nearly as possible a uniform bearing for the wearing surface.

Notwithstanding all the precautions and refinements of the later specifications where a sand bed is used, it has been shown that the defects were not overcome in the wearing surface, this being due to the fact that it is impossible to properly compact a sand bed varying in moisture content and thickness. Also, a wet sand cushion when dried out will shrink and leave hollow spaces, consequently defeating its function of providing a firm and uniform bearing at all times for the wearing surface. Another defect of the sand cushion is that it works up into the joints of the brick and prevents the joint filler to thoroughly penetrate and properly bond the wearing surface. In the repairing of many of our brick roads I have seen defects in the surface caused by the sand cushion coming up into the pavement at least 2½ in.

Wearing Surface.—The wearing surface of the pavement is composed of vitrified paving brick joined together with a filler. Smaller bricks were used in the early manufacture for brick pavements and without lugs. Later in order to obtain a uniform width of joint to take the filler the brick were made with lugs by repressing. The standard paving brick of today is 3½ in. in width by 8½ in. in length by 4 in. in depth, laying 40 brick to the square yard. These bricks are larger than the first brick manufactured.

The wire-cut lug brick came into vogue in 1910, the first wire-cut lug bricks being used by the New York State Commission of Highways in the construction of the Williamsville road near Buffalo. These brick have steadily increased in favor with paving engineers and are now universally called for. The experience of New York State with the wire-cut lug brick has been that it possesses uniform lugs and fiber sides, due to the method of manufacture. The fiber sides, which are always obtained in a wire-cut brick, give a greater bond strength at all times, while the uniform lugs insure a thorough and even penetration of the filler, and from a construction standpoint provide parallel joints, which means better construction. The square edge of a wire-cut brick in addition means a flush joint, which produces at all times a smooth wearing surface and one which will not cobble under traffic.

Two classes of joint filler are used to bond the brick units together, the cement grout filler and the bituminous filler. My experience and observation are that the results from the cement grout filler are superior and more durable than the soft filler and one which is absolutely necessary in the modern semi-monolithic and monolithic types of construction. If soft filler is used the old sand bed is more likely to be the design. New York State specifications for cement grout filler allow the use of grout made of 1 part cement and 2 parts of grout sand if machine mixed, and a grout made of 1 part Portland cement and 1 part grout sand if hand mixed. In general the specifications of today call for a grout made of 1 part cement to 1½ parts of sand. Machine mixed grout is, in the opinion of most paving engineers of today, far superior to hand mixed and at the same time is more economical in manipulating. Paving engineers recognize the necessity and importance of the grout filler and are taking every precaution in the selection of the materials and their application.

Brick Pavements with Cement Sand Beds.—Experience and observation have demonstrated that many failures in the wearing surface are due to the sand cushion, which engineers have endeavored to combat. The solution of this factor has been the development of the cement sand bed which provided a non-shrinking, rigid super-foundation, thus making the first step toward a brick monolithic type of construction. Brick pavements constructed with a cement sand bed are commonly known as semi-monolithic construction and from this type developed the true brick monolithic construction which is now being used by highway engineers. The semi-monolithic type is the same as other brick pavements constructed with sand cushions, except that a mixture of sand and cement mixed in general 1 part Portland cement to 3 parts sand, is substituted for the sand cushion. It is the practice to mix dry these materials thoroughly by machine in the proportions specified. The mixture when spread out should be screeded with a templet cut to the required contour of the finished pavement. Care should be taken to get uniformity, but hand rolling is not deemed advisable as it has been learned that a rolled cement bed does not insure a smooth wearing surface due to its great density. With an unrolled surface the brick as laid is always bedded in the cement sand super-foundation. The thickness advocated in general is a minimum of ¾ in. and a maximum of 1 in. It is my practice to wet the cement sand bed with a sprinkling can just ahead of laying the brick. Immediately preceding the grouting the brick surface should be thoroughly wet.

With present methods the semi-monolithic type of construction is better adapted to wide street construction than the monolithic. All precautions should be taken in the mixing and the application of the grout filler.

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*[illegible] convention of American [illegible]

The advantages of semi-monolithic construction are that it overcomes the defects of the sand cushion by insuring rigid construction in that it practically unites the wearing surface with the concrete foundation. The cement sand cushion at all times provides a perfect bond for the full depth of the brick. This type eliminates the shrinking which is common in a sand cushion and at the same time eliminates the hollow or rumbling noise which is common with the sand cushion type of construction. It gives a more economic and scientific design in that it provides a stronger slab with the same material.

Brick pavements with cement sand beds were built in Baltimore as early as 1906 and adopted as their type of construction in 1915. The cement sand bed was used in Jacksonville in 1910 and also in connection with the paving of the ramps of the Pennsylvania Railroad terminal in New York in 1910. It has been demonstrated here that shallow vitrified brick will stand up under heavy truck conditions when laid upon a cement sand bed. In this case fire clay brick 2¼ in. in depth were used. This work in the Pennsylvania terminal demonstrates that in many places a block of less depth than the standard block can be economically used, and, in fact, in the city of Syracuse an experiment was made by which a 3½-in. block was laid on a cement sand cushion with railroad tracks in the center on a street entering the city and satisfactory results have been obtained and I have in mind that the next pavement that we lay of this kind a 3-in. brick will be specified.

Brick Pavements with Green Concrete Foundations.—This type of construction is commonly known as the monolithic type and is better adapted for highway construction up to, say, 24 ft. in width or where a templet may be used to shape the entire width of road at one time. It was first used in highway construction near Paris, Ill. Proper consistency of the concrete foundation is essential for this type of construction. Care should be used in the proper spading and distributing of the concrete to prevent waves in the finished pavement due to possible difference in density. The concrete foundation is spread usually ½ in. high and formed by using a tamping templet which brings to the top a smooth mortar surface on which to bed the brick.

For this purpose there has been developed a mechanical templet which consists of a gasoline engine mounted on a cross frame with wheels, which is carried on the side forms. This power templet performs the double purpose of tamping and smoothing the concrete and in addition compresses it to better density. This templet moves at the rate of 4 ft. a minute and can be adjusted to different widths. The laying of the brick wearing surface should follow closely on the concrete foundation and should be inspected, culled and rolled before the cement has its initial set. For rolling the wearing surface a hand roller is advocated about 30 in. long, 24 in. in diameter, weighing from 600 to 900 lb. The rolling should follow immediately after the inspection so that the grout filler may be applied at once to secure the necessary bond with concrete foundation.

In this connection the so-called wire-cut lug brick is of special value in that it develops the full strength of the slab by reason of its superior side bond, due to its fiber sides, and assures penetration of the bonding material to all parts of the joints due to its uniform lugs.

The mixing and placing of the grout filler is of the utmost importance for this type of construction as in the construction of brick pavements of the other types and the same precautions must be taken in the selection of the materials and their application.

All the advantages claimed for the semi-monolithic type of construction will hold for the brick pavements constructed on green concrete foundations to which may be mentioned the added increment of slab strength due to the more perfect bond of the wearing surface and the concrete foundation. This type also eliminates the use of edges in highway construction, which reduces the cost. The use of the semi-monolithic and monolithic types have tended to develop the use of paving brick of less thickness which will result in economies, one of the most important being the saving in transportation charges. There should also be an economy in the first cost, together with a saving in actual manipulation.

In my opinion the day of the sand cushion on rigid foundation is ended and the satisfactory type is a cement sand cushion for village and city streets, and that brick pavements for highways should be constructed on a green concrete foundation.

In closing I wish to emphasize the paramount importance of proper design of highways to take care of modern traffic. To my mind a rigid foundation is absolutely necessary on main trunk lines and where truck traffic predominates or may develop in the near future. The use of motor trucks for commercial purposes has grown tremendously and it is our duty to design highways which will be able to stand their loads up to reasonable limits and with reasonable maintenance charges.

Cost of California Road Work Before and During the War

In order to get an approximation of the advance in cost of the state highway work due to war conditions, a study was made by the California Highway Commission of the contracts let in the two periods, before and since the beginning of the war. The period 1912 to 1916, inclusive, was taken as the prewar period. To compare costs fairly weighted averages were used. The inquiry was limited to the grading and to the concrete paving items of the contracts, these being by far the most important elements of the work and its cost.

The quantities involved were as follows:

	1912-16 (exclusive).	1917-18.	Totals
Grading, cu. yd.	6,750,000	2,339,000	9,089,000
Concrete, cu. yd.	882,300	252,900	1,135,200

The following tables show by years the average price paid for grading and for concrete during the prewar period and during the war.

WEIGHTED AVERAGE CONTRACT PRICES, 1914-1916 (INCLUSIVE).

Year.	Grading[1] (per cu. yd.).	Concrete including all materials (per cu. yd.).	Sand delivered (per ton).	Broken stone and gravel delivered (per ton).	Cement delivered (per bbl.).	Concrete[2] exclusive of materials (per cu. yd.).
1912	$0.39	$5.82	[3]....	[3]....	$1.61	[3]....
1913	.46	5.91	$0.56	$0.58	1.65	$2.56
1914	.51	6.75	.54	.85	1.70	3.03
1915	.45	6.26	.58	.76	1.74	2.84
1916	.37	6.37	.60	.76	1.80	2.98
Weighted average	$0.49	$6.35	$0.56	$0.78	$1.70	$2.92

WEIGHTED AVERAGE CONTRACT PRICES, 1917 AND 1918.

Year.	Grading[1] (per cu. yd.).	Concrete including all materials (per cu. yd.).	Sand delivered (per ton).	Broken stone and gravel delivered (per ton).	Cement delivered (per bbl.).	Concrete[2] exclusive of materials (per cu. yd.).
1917	$0.73	[4]$8.03	$0.66	$0.86	$1.80	$4.17
1918	.78	[4]10.51	1.05	1.82	2.20	5.53
Average	$0.74	$8.67	$0.76	$0.96	$1.90	$4.51

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[1] Includes all classifications.

[2] This is the item upon which the contractors bid in most cases the state supplies the materials.

[3] In 1912 the contractors in all cases except one furnished the concrete aggregates

[4] In 1917 and 1918 the paving concrete was enriched from 1:2½:5 mixture to 1:2:4. In the prices stated this has been allowed for

From the tables it is seen that the average cost of the grading has increased from 49 ct. per cubic yard to 74 ct., or 51 per cent.

The concrete in place including all materials has increased from $6.35 per cubic yard to $8.67, or 36.5 per cent.

The last column in both tables is perhaps the most interesting. In most instances the commission delivers to the contractor at the freight siding nearest to his work all of the materials needed for the concrete. The contractor hauls these materials to the work and places them. The figures, therefore, reflect directly the increased cost of labor. The average contract price has advanced from $2.92 per cubic yard to $4.51, or 54.5 per cent.

As in most statistics the tables lack one element which can not be well included. It is possible that during the pre-war period the lengths of haul from the freight sidings may have been longer or shorter than in the other period. It is not thought, however, that this element would affect the averages to any considerable extent since the quantities in-

[illegible] work is so stand[illegible] [illegible] features.

[illegible] in fact somewhat [illegible] 191[illegible], and 1918 the com[illegible] [illegible] cement and [illegible] the minimum [illegible] freight trains. These [illegible] computations upon which [illegible].

Liscensing of Civil Engineers

[illegible] on legislation of the [illegible] was directed to gather information concerning state engineering license laws and to draw up a standard license law. In a preliminary report, L. K. Sherman, chairman of the committee, reviews the existing and proposed laws, and outlines the essentials for [illegible] of existing and proposed laws was [illegible] December 18. Further extracts from the report are given below:

Is an Engineers' License Law Desirable? Most of the bills for engineers' license laws that have been introduced into the state legislatures have failed to pass. This has been due to lack of support by the engineers themselves, and this in turn has been due to (a) indifference on the part of engineers; or (b) objections to the form and details of the bill; or (c) lack of organized support.

A review of the first agitation for license, about 1909, records marked opposition on the part of many engineers. The American Society of Civil Engineers, and the Boston Society of Civil Engineers, and the Pennsylvania Society of Engineers, all passed resolutions against the enactment of engineers' license laws. Among the arguments against licensing were: Not necessary, because the public is protected against incompetence and mountebanks by employing only members of high-grade engineering societies. A license does not guarantee competency. Engineers are not employed by the general public as individuals the same as it employs doctors or lawyers. Not practical to define any comprehensive engineering work, must limit law to one particular field or surveying, etc.

The advocates for licensing have answered the above objections in pointing out that society membership cannot be reorganized by the public and does not weed out incompetency. That licensing does bar the most flagrant cases. That the physicians' and lawyers' licenses do not prevent the appendicitis patient from employing an eye and ear specialist, or the applicant for a divorce employing a corporation attorney, and yet such licenses are of recognized public service. The architects, doctors, lawyers, to say nothing of the plumbers, engine men, and barbers, are licensed, and they have found it desirable for themselves and have demonstrated to the state legislature and to the supreme court that it was desirable for the public.

While there is no official record, there appears to be a growing opinion in favor of engineers' license laws, more especially in the states where such laws exist.

It would be interesting at least, if upon the submission of a proposed license law by this committee, the matter was referred to a referendum vote of the association.

In view of the increasing number of states passing engineers' license laws, it is highly desirable that some uniformity be established and reciprocal action entered into.

Unquestionably, the chief cause for the failure for passage of license acts has been due, as was the case in Iowa in 1910, to the lack of support by a strong executive and business organization. For the first time in the history of engineering societies the American Association of Engineers now furnishes that executive organization.

What Class of Engineering Work Should Be Covered by a License Law?—No existing license law includes all the branches of engineering. Some states include surveying, others civil engineering. Illinois includes structural engineering. Other states license the practice of hydraulic and irrigation work and mining engineering. Electrical and mechanical engineering are not licensed, to our knowledge, but almost invariably the operator of a steam or electric plant requires a license. The fact that steam boilers, elevators, and electric wiring are subject to either state of municipal inspection probably accounts for this. Inasmuch as there is no apparent demand for license by the mechanical engineers, and as the works of the mechanical and electrical engineers can be readily proven by actual tests, which is not the case, in general, in the works of the civil engineer, it is here suggested that the committee consider only a license law as applying to civil engineering or specific branches thereof. The views of the members of the association and others upon this point are invited.

The Essentials of an Engineers' License Law.—The desirability of a license law for the engineer, architect, doctor or plumber individually or as a class does not furnish, in law, the slightest basis for its existence. It is essential to demonstrate to the legislature and the court later, if necessary, that the license law will serve for the conservation and protection of life, health, or property of the public at large. Obvious as this principle appears, its oversight has led to many faultily drawn acts and to much wasted energy.

Protection for the public can be secured not only by a state license to the properly examined and qualified practitioner, but it can also be secured by the requirement for approval of plans and by inspection by duly qualified state officials. For example, the approval of plans and construction for dams is required by state boards in Connecticut, New York, and Pennsylvania. Almost all states require approval of plans for sewage disposal by the state board of health, and many states make the same requirement for water supply. State and municipal building codes furnish an example. Massachusetts requires state approval of plans for railway bridges, and other state utility commissions through their engineering staff supervise engineering construction to a greater or less degree. State supervision as just outlined is the more obvious procedure to the public. Examination and licensing acts require initiation from the engineer.

The essentials for a satisfactory engineer's license law, as set forth in the form suggested by the American Society of Civil Engineers and as incorporated in the Florida act, and to a modified degree in all other existing acts, are as follows:

1. An exact definition of civil engineering as illustrated by a statement of specific works covered.

2. The appointment of a board of examiners, usually five, and made by the governor. Requirements for membership of the board. Appointment of a secretary.

3. Minimum requirements from candidates in qualifying for examination. Six years' experience, one of which is in responsible charge. Two years allowance for graduate of approved technical school. It has been suggested that a minimum educational standard be a preliminary requirement.

4. Exemptions from examination. Those in actual practice prior to the act. (To avoid an expost facto law.) Those licensed in other states having equal requirements. It is suggested that no additional fee be required of such parties other than a nominal registration fee. Consulting engineers for licensed engineers. Also sufficient time for engineers of other states to permit them to register without interruption of work. (See Louisiana Law.)

5. Reciprocity with other states.

6. Conditions and limitation of the examination.

7. Penalty for violation of the act. It has been suggested also that a license is required to qualify an expert witness and that no legal collection for engineering fees be granted unless licensed.

9. Required seal on plans.

10. Investigation and prosecutions.

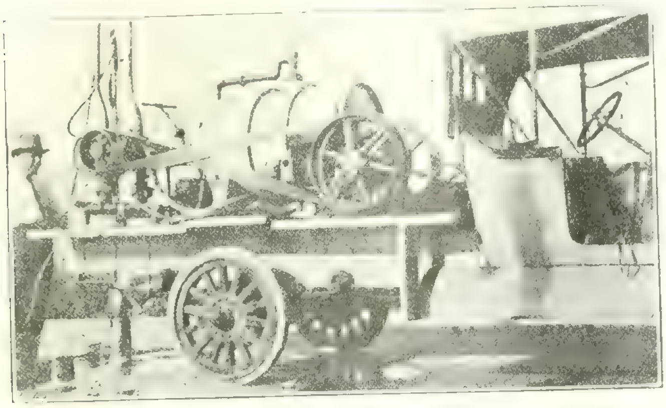
The board to be active and responsible for this burden.

When to Use Drag on Road.—In a paper presented last month at the 17th annual meeting of the Ontario Good Roads Association, Mr. F. A. Senecal, County Road Superintendent of Prescott and Russell Counties, Ontario, stated that in his experience, the proper time to use a drag on the road depends on two factors: The nature of the soil, and the traffic over the road. An earth road mixed with gravel should be dragged when very wet, as also when the traffic is light on any road. But, when the traffic is considerable, it is useless to drag it until the earth has sufficient body to prevent cutting by the wheels of vehicles. This matter, however, can be easily adjusted by a few trials with the drag under various conditions of the road.

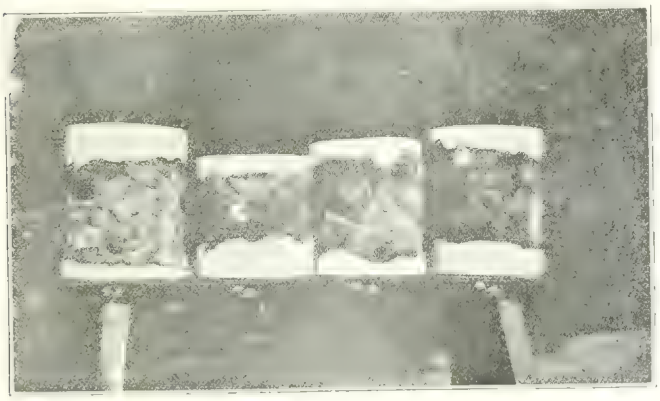
Core Drilling Outfit for Test Specimens from Pavements

A Calyx core drilling outfit mounted on a light motor truck is employed by the testing division of the California Highway Commission for securing test samples from finished pavements. With this outfit a 4½-in. cylinder is cut from the pavement, furnishing very satisfactory specimens for compression tests.

The drilling power is furnished by a 3-h.p. gasoline motor; the steel core cuts by grinding on the steel shot. Where the coarse aggregate of the concrete pavement is extremely hard and tough, the drilling takes from 30 to 40 minutes. The average concrete pavement can be drilled in from 6 to 15 minutes. The drilling of concrete pavement 5 or 6 years old made with gravel which consists largely of indurated sandstone required from 6½ to 10 minutes. Samples made of broken rock from a chert quarry were bored in from 10 to 12 minutes. Concrete made from boulders of extremely hard andesite required from 30 to 40 minutes. The actual time required for boring will be somewhat of an indication of the wear resisting qualities of the pavement. The borings taken from the pavement are valuable also in furnishing an exact record of the thickness and, also, in showing how thoroughly the concrete was mixed at the time of laying.



Core Drilling Outfit Mounted on Truck.



Cores from Concrete Pavement Prepared for Compression Test.

Tests by the laboratory of the finished pavement made with a 1:2½:5 mix at the end of 3 or 4 years indicates a total compressive strength in excess of 3,000 lb. per square inch.

Up to the end of 1918, the laboratory had only tested pavement constructed of three different kinds of aggregate; namely, broken rock, sandstone gravel and volcanic rock gravel, but these test pieces, taken from different parts of the highway along a stretch 20 miles in length, have all shown a total compressive strength in excess of 3,000 lb. per square inch.

The holes made in the pavement after the removal of the core are about 5½ in. in diameter and are usually repaired with neat cement and broken rock. When this mix is used, the cement sets up and gains sufficient strength in a few hours to make unnecessary any careful plan of protecting or curing the repaired holes.

Day Labor, Force Account and Bonus System in Highway Work*

By CHARLES M. UPHAM,

Chief Engineer, Delaware State Highway Department.

In looking into this subject I find that with some officials in certain sections of the country the method of doing work by day labor is very popular, but compiling the opinions of a great number of highway engineers, I think that the day-labor system has become unpopular and has the name of being costly and expensive and is without any of the advantages claimed for the contract system.

When Day Labor System Gives Good Results.—In localities where the supervision of the day-labor system has been efficient and the organization permanent, this system has produced and is still producing good results in construction at reasonable costs, costs that often are lower than those obtained by the contract system. Advocates of both the day-labor and contract system state that, properly controlled, their system produces better work. With proper supervision, inspections, and specifications the same results can be obtained either way, so that advantages can be compared merely to costs. By theoretical analysis it can be shown how the day-labor system is not as costly as the contract system, for it does not include the contractor's profits, nor the percentage that is included in the proposal for contingencies.

No State officials desire contractors to do work without profit, nor do they want the uncertainty of their plans and specifications to make the contractor's proposal become a gamble. It is accepted by all that the contractor should be paid the cost of his work plus a reasonable profit. In contract work there is generally figured a fair profit and also a percentage for contingencies that do or do not happen. These percentages are in addition to the actual cost of the work which in itself includes the pay for capable foremen, efficient supervision, and generally an allowance for the contractor's salary, provided this is not included in the percentage that is added to cover the profits. In other words, the contractor has provided for payment of all his expenditures plus a reasonable profit and an allowance for contingencies. If these contingencies happen the contractor should receive a payment covering them, but if they do not happen it simply makes a gamble out of the proposal, with the contractor the winner.

Why Contract System is Favored.—The day-labor system on the other hand does not include either of these charges of profit or contingencies, but it is the resulting expenditure of the actual cost of the work. Why is it then that day labor has not become universally adopted? Why is it that the day-labor system is looked upon with suspicion and turned down by engineers wherever there is a possibility of doing work by contract system?

Many cities, towns, and States began their public work by day labor. After a short period we find that in nearly every instance many of these cities, towns, and states have adopted the contract system to protect themselves, and they now get their work done at more reasonable costs.

That the fear of high costs resulting from the day labor system existed in earlier days is shown by the fact that early in 1800 we find engineers advocating the abolishment of day labor. It is said that Telford estimated the cost of work produced by the day labor system was 50 per cent higher than by the contract system. A railroad engineer informs me that he was somewhat surprised that the cost of day-labor construction was from 25 to 100 per cent higher than contract work. It is said that in 1909, Metcalf and Eddy went into the comparison of costs of day labor and contract work, and in a report to the Boston Finance Commission the result was in favor of the contract work. In a few other instances, however, the results show that the work done by day labor is cheaper than that done by contract, but these cases are in the minority. From these statements it seems that the results point in favor of the contract system for securing good work at reasonable cost.

Development of the Two Systems.—Before condemning the day labor system, however, a comparison of the development of each system is interesting.

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*From a paper presented at the Chicago Road Congress.

[illegible] contracts for [illegible] n which [illegible] certain num- [illegible] shovelers [illegible] While this was a con- [illegible] The effect in gen- [illegible] but the [illegible] certain extent on [illegible]

[illegible] of the amount of work [illegible] rather than the number of men working. This [illegible] made this sys- [illegible] me popular among contractors. By securing the [illegible] rvision and using certain ingenious devices, short [illegible] were developed and larger profits resulted. As for the owner, the work was completed quicker and at no greater cost. The contract system thus became popular for these various reasons, and especial attention was paid to this system both by owners and engineers. Specifications and detailed plans were developed and complete control of the work was secured. Costs [illegible] the successful contractors maintained an organization of the best supervision and most up-to-date methods and machinery possible and consequently they could complete work at a comparative low figure and still make a profit.

What became of the day labor system in the meantime? [illegible] states whose officials [illegible] commence work by the day labor system. Many times the official would have had no experience in the particular line of work that he undertook, and for supervision he would fill these positions with his friends or political supporters. The result of this poorly organized, inefficient, supervision was high costs, and sometimes poor and faulty work. About the time the official became experienced and could have produced satisfactory work at reasonable cost, a house cleaning removed him from office and the same thing was done all over again by the next official. The day labor system has been abused by such methods as these, and there has never been any great attempt to develop this system to the degree that the contract system has been developed. The force account method may be a step in the development of the day labor system, and the cost plus percentage or the cost plus fee method is another stage in the development of the day labor system.

Cause of High Cost of Day Labor Work.—High cost in day-labor construction was many times blamed on the principles of this system, but as a matter of fact the real reason was the inefficient organization and the lack of control. Because of the high costs, many cities and towns immediately condemned the method of day-labor system, and without any attempt to overcome the weak points in the system inaugurated the contract system, a system in which the control and methods had already passed through the experimental state and now was on a developed, definite, and sound basis.

With the same regulations and restrictions and the same personnel in day-labor system as in contract system, both should carry on the work at the same cost to the owner. In the contract system the contractor's profits and payment of the possible contingencies must be added to the costs.

A few reasons why the day-labor system is expensive is because this system is generally harnessed by laws that limit the payment of the foreman and supervisors, and thus deprive this system of the privileges of the high class of supervision of the contract system. Many times the law also states just what the labor shall be paid. This again is a serious obstacle for the day-labor system to combat.

The limit of salaries of foreman and suervisors subjects the day-labor system to many obstacles, for very often it happens in this day-labor system the limit in wages commands supervisors and managers of only ordinary ability, or only partially experienced in their particular line.

The contract system on the other hand is not restricted as to obtaining the best supervision of labor. The successful contractor is a man of exceptional ability, one who represents the survival of the fittest. With this ability and the resources for efficient supervision the contract system is [illegible] basis.

Day Labor Principle Itself Not at Fault.—Therefore it [illegible] should not be condemned through reasons of the principles of the system itself, but should be passed through a period of development to the same extent the contract system has been developed. It should not be ridden with laws that combat the motives of the system. It is true a few steps have been taken in this development in the form of force-account work and in the cost plus percentage or cost plus fee system. The day-labor system will never be universally popular or successful until it is given the same freedom as the contract system and is controlled by the same standard of supervision and efficiency.

Bonus System for Labor.—In practice we find that among contract laborers some men do more work and better work than others while they all may be receiving the same compensation. This does not encourage the men to do their utmost but is conducive to producing a matter of fact interest in their work. The ideal condition would be a piece-rate system, to pay all the men in proportion to the amount of work they turn out. This is not always possible in each individual case but it can generally be developed with groups of men at least.

By analysis the bonus system means a piece-rate system with a minimum guarantee. An interesting fact that happened during the past construction season describes one of the advantages of the bonus system: Two contractors, 7 miles apart, on the same road, having practically the same territory from which to draw labor, were constructing a concrete road. Both contractors at the beginning paid $4 per day for labor. The one added a bonus system, the other stated he would raise the wage if necessary. The man paying the bonus averaged $4.25 per day in paying for his labor. Consequently he soon drew more and better labor. The second contractor seeing his men leave, raised his wages to $4.25 and then to $4.50, and finally to $5, but at no time did he complete as much work with the same number of men as the contractor that paid $4 minimum wages plus a bonus. This was really the piece-rate system with a minimum guarantee.

The bonus system made each man a sub-contractor and his wages depended on his efforts and the amount of work completed. If the day labor system of doing work could have the benefit and advantage of this spirit among its labor, a great step in developing the system would be taken.

While the idea of bonuses seems to be old, it has not been used to any great extent especially among contract labor. The only reason for this seems to be that this branch is another detail not yet developed.

To develop the bonus system among contract labor, as it has been developed in the industries, may at the same time make it possible to produce a labor that can be used successfully in the day labor system and we may then expect many of the present day difficulties for the successful use of the system to be overcome, and we might possibly find the same efficiency and control in this system as is found in the industries. The operation of that system of day labor that has been found so costly and so unpopular among engineers, may, with the help of the bonus system be developed on an economic plan, closely approaching in practice the theoretical principles of the day labor system, and becoming a popular method of carrying on highway construction.

Government Will Sell 57,000 Tons of Rail.—The government plans to sell at prevailing market prices the surplus stock of 80-lb. rail and 25-lb. rail ordered for the American Expeditionary Forces overseas, but not required, due to the signing of the armistice. There are about 50,000 tons of 80-lb. rail and about 7,000 tons of 25-lb. rail; also large quantities of crossings, slip switches and turnouts. The bulk of this material is at port, readily accessible for loading. All sales are being conducted through the office of Director General of Military, Washington, D. C.

Contract Work Most Satisfactory.—Road work in Manitoba carried out by the contract system has proved more satisfactory than the work done by day labor, stated Mr. M. A. Lyons, chief engineer, Manitoba Good Roads Board, in a paper presented before the Engineering Institute of Canada. About 95 per cent of the bridge work is done under contract and about 75 per cent of the road work. While in a number of cases roads constructed by day work with local labor have been cheaper in first cost, when the finished appearance of the work is considered, the contract work is, in 95 per cent of the cases, more satisfactory, and any slight extra cost is justified.

Road Surfacing with Lake Shore Gravel or Sand

By L. U. MARTIN.

During the summer of 1913 we built under contract 7 miles of road on State Route No. 1 between Starbuck and Glenwood of this county. Gravel for 1½ miles in the contract was specified from a certain pit which from surface indication showed gravel but which on being opened up proved to be only a small streak and not of sufficient quantity to be worth while.

As funds were not available to haul the necessary gravel from other pits on this particular stretch we were compelled to resort to the use of shore gravel from the lake, which brought the haul to within the limits of the contract.

This material was rather fine and I was repeatedly informed by people from both towns as well as the adjacent farmers that the experiment had been tried repeatedly for the past 25 years and that it had never been successful, that it would not pack and would only spoil the road and that we would have to remove it later. As it was my first season in the locality I was rather pessimistic after all this good advice, and nearly called a halt on the work several times.

The sand was hauled on about 4 in. thick. Onto this we put a heavy disc harrow well loaded down with rock and disked the heavy clay bottom up into the sand and well mixed it. Drags smoothed this down for the next coat which went on about 3 in. thick. Over this we put about 1 in. of good clay and disked again. A grader was then used on the edges and these were covered about 2 in. deep with clay from the shoulders for a width of 2 ft. to give additional clay and to prevent the washing away of the sand during rains. Following this we had about two weeks of the driest weather that I have ever seen and it was all I dared to do to show myself in the neighborhood of the work. Car after car plowed in and got stuck, teams could not haul a load through it, in brief it was impassable. Then rain came to our rescue and the road began to be passable. After about three good rains it settled down and has ever since been the best stretch on the road.

A few pockets would develop during dry spells but these were promptly mixed with clay by the maintenance man on the beat, and as soon as rained on were as good as could be. As the material was none of it over a B. B. shot in size there are no rocks to bother, and the road is as smooth as can be made. No waves have ever developed to bother.

The surprising feature to us, however, is the wearing quality of this surfacing. All of the rest of the graveled portion of this road has either had to be renewed in the past two years or is entirely worn away, although the gravel on a good portion of it was of the very best of pit run material locally available and was put on fully as heavy and parts much heavier than this section. Also all of these other stretches have shown a decided tendency to develop waves unless closely watched. This section is still in good shape and will not need resurfacing for at least two more seasons.

The Necessity of a Broader Handling by the Federal Government of Road Building

The work of the agricultural department in connection with highway building has never measured up to the responsibility which rests upon the government in helping to give the country a complete system of highways. And now as the country comes to a realization of the necessity of building permanent highways on a vastly greater scale than ever before, it must realize the importance of taking the entire business out of the hands of the Department of Agriculture. The road question in its relation to the life of the nation is almost as important as agriculture itself. The road question has now gone far beyond merely the matter of providing good highways for the handling of farm products, although that is important to the extreme.

A great system of co-ordinated highways, reaching every part of the country, built strongly enough to stand the wear and tear of heavy motor trucks, must be constructed. They should be wide enough to meet the needs for many years of the ever-expanding automobile and motor truck business; they should be built solidly enough to stand the tremendous strain which is to be put upon them during the next few years.

The agricultural department is not in a position to handle a proposition so big as this. Indeed, with all due credit to what the men in that department may have done in the past, we do not believe that there is anyone connected with the Department of Agriculture who is just fitted for such a job. Moreover, the work of the Department of Agriculture is sufficiently absorbing, with its limitless field of expansion, as to tax the full energies of the very best men which the department can bring to its work. It should not for a moment be tied up with the handling of great road problems confronting the country.—Manufacturers Record.

Systematic Road Dragging Financed by Local Subscription

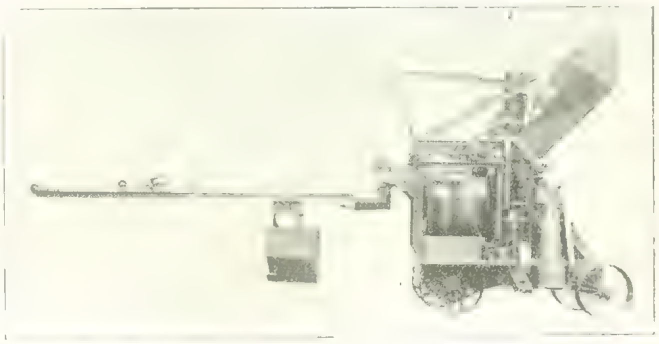
An 8-mile road in Austin county, Texas, in large portions of which is through black prairie country where the soil becomes very sticky and disagreeable in wet weather has been maintained for 3 years at a cost of $100 by the method described below:

The people living along a section of the road form what they call "Dragging Clubs," each member pays $2.50 per year. A supervisor is appointed to direct the work of dragging the road. Each member of the club is entitled to at least one day's work per year dragging the road, for which he is paid out of the funds of the club. When the road needs dragging, the supervisor calls upon one of the members of the club to drag it, and when he has finished, he pays him for his work. Membership in the club does not mean that the member must work on the road, but he has the privilege of working on the road and he is paid for the work he does. People living in community centers often pay dues and belong to several different clubs.

A representative of the State Highway Department reports as follows on the plan: "The results obtained through this method are eminently satisfactory as shown by the state of the roads in this community. We found these roads to be smooth and well drained, free from chuck holes and mud holes, and in every way in a most satisfactory condition, and when we consider the extremely hard weather conditions which the country has experienced during the past five months, the results shown here are remarkable, and they demonstrate very forcibly the value of systematic dragging in the maintenance of earth roads."

The 1919 Model Rex 14-E Paver

Among the recent developments of interest to paving contractors is the announcement of the Chain Belt Co., Milwaukee, of its 1919 model Rex 14-E Paver. The Rex 14-E is equipped with an enclosed traction transmission of the type used in heavy tractors. This machine is equipped with a loader 90 in. wide, thus permitting dumping of two wheelbarrows into the loader at the same time. The mixing drum is made of cast semi steel in two places, bolted together by means of flanges and is of the bulge type. It is rated at 14 cu. ft. of mixed concrete. The machine has a 2 bag capacity for proportion of 1-3-6 or 1-4-6 and has a 3-bag capacity for proportions of 1-2-4 or 1-2-3½. The discharge of the concrete is 60 in. from the ground level, allowing a good angle for spouting when spouting is the desired method of distributing. In this case a 15 ft. distributing spout which permits an extremely wide radius of operation is furnished. For the boom and bucket method of distributing the Rex 14-E is equipped with a 20 ft. distributing boom supported by



Rex 14-E Paver 1919 Model.

[illegible] capacity to [illegible] Another [illegible] of the [illegible] supporting [illegible] equipment [illegible] stability [illegible] The power equipment [illegible] and a 12 hp boiler. The over all dimensions of the machine are, height [illegible] It is stated that the Rex [illegible] has [illegible] with no difficulty.

Minimum Width of 20 Ft. Recommended for Pavement on Trunk Highways

A width of at least 20 ft. [illegible] on trunk highways was recommended by the committee on "Reconstruction of [illegible] Highways Were Adequate [illegible] Traffic," in a progress report submitted last month at the annual convention of the American Road Builders' Association. The committee stated for each additional line of traffic 9 ft. more of paved surface should be added, and that the minimum width of shoulder should be 5 ft. Other recommendations of the committee were as follows:

Present drainage systems should be examined and placed in such condition that they will function properly. Such [illegible] necessary to keep the subgrade dry.

All foundations of new construction should be of concrete; and when present pavements can be used the widening should be of same kind of construction as the portion to be utilized.

Pavements on trunk line highways should be of concrete, brick, wood block, stone block or bituminous concrete (of the mixed type).

Wherever possible traffic should be maintained during construction, especially where the alternative is indirect or inadequate detours. This can be accomplished in some cases by carrying the traffic along the side of the roadway; in others it has been found possible to construct the pavement one-half at a time. It is suggested that these methods be given consideration even though they involve a greater immediate cost than would the closing of the roadway. It is certain that better and surer provision will be made for the maintenance of traffic.

The committee consisted of Major Fred A. Reimer, A. G. Thompson, Lieut.-Col. W. D. Uhler, Chas. M. Upham and H. Eltinge Breed, chairman.

Personals

Fred M. Harper, Butler, Pa., has been appointed superintendent of highways of Butler County.

E. J. Bourgeois has been appointed city engineer and superintendent of the water department of Bemidji, Minn.

Gustav Rasmus, mechanical and civil engineer, has been appointed chief of the City Industrial Bureau of Denver, Colo.

George E. McMinch of St. Joseph, Mo., and Cyrus O. Raine of Canton, Mo., have been reappointed State Highway Commissioners of Missouri.

E. Norris Hobart, for the past year county road superintendent of Quay County, New Mexico, has been appointed assistant state engineer of New Mexico.

B. F. Patterson has been elected president of the Franklin Asphalt Paving Co. of Columbus, O. The company was organized recently and will engage in street and road construction.

Capt. John W. Toyne, utilities officer for Camps Chickamauga Park and Fort Oglethorpe, Ga., has received his discharge from the service and will again open his engineering office at South [illegible]

M. C. Polk, county surveyor of Butte County, California, has been elected president of the County Surveyors' Association of California. The other officials are P. A. Hanlon, of Alameda County, vice-president, and Drury Butler, Sacramento County, secretary and treasurer.

R. M. Hubbard of New Boston has been appointed chairman of the State Highway Commission of Texas to succeed Curtis Hancock, resigned. C. N. Avery of Austin was appointed a member of the commission to fill the vacancy caused by the promotion of Mr. Hubbard, who has been a member of the commission for over a year.

Ira W. McConnell, formerly chief engineer for Stone & Webster, and later works manager and assistant general manager for the American Shipbuilding Corporation at the Hog Island Shipyard, has become associated with Dwight P. Robinson & Co., Inc., constructing and consulting engineers, 61 Broadway, New York City, in the capacity of vice-president.

Obituaries

Robert E. Twohy, vice-president of Twohy Bros., contractors, [illegible]

Emil C. Braun, formerly chief engineer of the street railway system at St. Louis, Mo., died March 23 at Chicago.

Harford Toland, one of the builders of what is now the Norfolk & Western Ry., died March 26 at Columbus, O., aged 82.

Capt. [illegible] Hedrick, junior member of the firm of Hedrick & [illegible] engineers, Kansas City, Mo., died March 6 at [illegible] He was 28 years old.

Charles [illegible] Burrus, a civil engineer for over 53 years connected with the New York State Engineer's office, barge canal [illegible] in various capacities, died March [illegible] at Albany, N. Y.

Industrial Notes

The Bucyrus Co., South Milwaukee, Wis., has opened a branch [illegible] building, Minneapolis, Minn. The office [illegible] of F. N. Crawthorne, Jr., northern sales manager.

C. E. Hagar, [illegible] production engineer of the Mid West [illegible] has been appointed sales manager [illegible] Conveying Corporation, Chicago, manufacturer [illegible] steam ash conveyor and other ash handling [illegible]

Trade Publications

The Blaw-Knox Co., Pittsburgh, Pa., has brought out an attractive [illegible] describing the use of Blaw forms in road construction. The publication contains illustrations of various installations of these forms on paving jobs.

The Barrett Co., New York, has issued an 80-page booklet entitled "Tarvia Road Book." The book was prepared by the technical department of the company and contains many tables and much information of interest to highway engineers, contractors and road builders.

"When the 'Seat' of a Road Wears Out" is the title of a booklet issued by the Jaeger Machine Co., Columbus, O. It outlines [illegible] constructing and repairing roads through the use of [illegible] concrete made by the cold mixing process. Application of the Jaeger mixer to this work is illustrated and described.

News Letter

St. Louis Items.

Chas. Stoner was in town several days last week. Reports his team outfit idle at Mendota, Ill.

Charles Blyth, who has not been in our neighborhood for 8 or 10 years, came in the other day from Tama, Iowa, looking up work for his outfit.

Cook & O'Brien were awarded a small county road job near Wichita, Kans.

R. T. Amis at Appleton City, Mo., wants to rent a small steam [illegible] three months on his work there.

Mulvill Bros. of Alton, Ill., were awarded the contract for changing Bay Creek Channel under the Chicago & Alton tracks at [illegible], Ill.

R. M. (Mike) Quigley passed through here the other day on his way from Carbon, Ind., where he has been stripping coal to Denver, Colo. Mike promised us a return visit on his way back [illegible]

A. C. Esser resigned his position here with the Western Wheel Scraper Co. and with Jimmie Carroll has organized the Central Equipment Co., with offices in the Title Guaranty building.

Friends of Chas. Mulvill, the popular Alton, Ill., contractor, are urging him to become a candidate for Mayor of his city. If Charley can be induced to make the race he will have to be reckoned with as a formidable candidate. He is a Democrat in politics and belongs to no faction. He is also one of the big business men of Alton and is independent of any local influences. We hope in the next issue to be able to report Chas. Mulvill as being nominated on the Democratic ticket for Mayor of Alton, and if nominated it is a foregone conclusion he will be elected.

Roberts Bros. & Peterson have moved a part of their outfit on to the Burlington R. R. in southern Illinois.

The J. J. McCaughey Co. have moved their Chicago headquarters to the Security building. Frank J. McCaughey, vice-president and treasurer of this company, will be pleased to have all of their old-time friends call on them there. They are also in the market for any kind of railroad work. Have several good outfits idle.

A sharp decrease in the cost of construction, as shown by bids for building three sewers, opened by the Board of Public Service, encourages the board to believe that low bids may be received for approximately $375,000 worth of street improvements which have been advertised for, President Kinsey of the board said. The sewer bids showed an average reduction of about 15 per cent from similar bids received a year ago, and rejected because of their high cost, Kinsey said. If the street bids show a like decrease in cost, the board expects to award contracts for several street and alley improvements, which will give work to a large number of men, according to Kinsey. The receipt of acceptable bids at reasonable figures for the street work will result in a resumption of municipal construction work, Kinsey said, and would be followed by the letting of contracts later for many improvements halted by war conditions.

A. Manegold & Co. were awarded the contract for grading about 100,000 yards of work for the Southern Wheel Co. at Euclid avenue and Terminal Belt R. R. here.

Geo. H. Reinecke is back here from Pennsylvania. Going to remain this time.

M. Brian, Claremont, Ill., has two teams that he wants to put on a small piece of fresno work or will work his teams by the day.

H. F. (Big) Riley, of Clapp, Norstrom & Riley, has been attending a number of government mules sales lately. Riley is always around where he can pick up bargains.

Jim Dunn, baseball magnate and a member of the firm of Dunn-McCarthy, took a flying trip to St. Louis the other day. Did not have a minute to spare, but promised to return and entertain the [illegible] baseball team meet the St. Louis Browns. Not much new to report in the contracting line right now, but may have something to say about them in next issue.

Sewer contracts totaling $75,000 were awarded by the Board of Public Service. The contracts were: Letting No. 856, for constructing sewers in Oakland Avenue Sewer District No. 2, Bates & Martin, $15,028. Letting No. 857, for constructing sewers in Arloe Sewer District No. 1, the George G. Prendergast Construction Co., $52,522.20. Letting No. 858, for constructing sewers in Arloe Sewer District No. 2, Bates & Martin, $9,689.40.

Contractors when in want of labor or work for their outfits write Koenig's Labor Agency, 612 Walnut St., St. Louis, Mo., or [illegible] Kansas City, Mo.

A. B. KOENIG.

Waterworks and Hydraulics Monthly Issue

ENGINEERING AND CONTRACTING

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The *articles* in the first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering and contracting field. The *articles* in the first and last issues of each month (1st and 4th Wednesdays) completely cover county engineering and highway engineering and contracting. The *articles* in the third and last issues of each month (3rd and 4th Wednesdays) completely cover steam and electric railway location, design and construction. See the "mast head" on the first page of the Weekly News Section for information about our weekly contract news. See Advertising Page 63 for Subscription Coupon.

Roads and Streets—1st Wednesday
- (a) Roads
- (b) Streets
- (c) Street Cleaning
- (d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
- (a) Waterworks
- (b) Sewers and Sanitation
- (c) Irrigation and Drainage
- (d) Power

Railways and Excavation—3rd Wednesday
- (a) Excavation and Dredging
- (b) Rivers and Canals
- (c) Quarries and Pits
- (d) Railway Construction—Steam and Electric

Buildings and Structures—4th Wednesday
- (a) Buildings
- (b) Bridges
- (c) Harbors Structures
- (d) Miscellaneous Structures

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Should Engineers Be Required to Study Current Engineering Literature During Office Hours?

"I have ceased reading engineering periodicals. They publish no new principles and it is impossible for a practicing engineer to remember even a small fraction of the details that are printed. It is all right for a young engineer to read engineering periodicals, mainly to ascertain how to apply the principles that he has learned at college. But after ten or twelve years of such reading, it ceases to be necessary. At least, so I have found it."

In substance this was what a prominent consulting hydraulic engineer said to the editor thirteen years ago. It happened that this engineer had designed a filter for removing algae from the lake water used by a small water company. The filter had been built at a cost of $10,000 and had proved a failure. Another civil engineer, with very little experience in hydraulic problems, but studious, had told the owner of the water plant that he need not build a filter, for the algae that at times gave the water its bad taste could be killed by dosing the water with copper sulphate, at a cost not exceeding $100 a year. The owner had rejected this suggestion because it seemed to him incredible that the experienced hydraulic engineer would recommend a filter if a cheaper way of removing the "sea weed" were available. But when the filter failed to accomplish the purpose, the owner tried copper sulphate and found that it worked perfectly.

All this the editor narrated to the hydraulic engineer who had said he could learn nothing new by reading engineering periodicals. For a while the engineer was inclined to doubt the story. He had never heard of the use of copper sulphate for such a purpose. When he was shown some articles describing its effective use, he acted in a manly way, admitted that he had erred in following a non-reading policy, and resolved never again to apply the theory that "an old dog can't be taught new tricks."

While engineers rarely go to such an extreme of indifference to current engineering literature, it remains a fact that relatively few engineers avail themselves even of a small fraction of the useful engineering information that is published every month. One excuse or another is given for not systematically studying the current engineering practice; but we have yet to [illegible]

28 Pages = 40 Pages

The 28 pages of articles in Engineering and Contracting contain as many words as 40 pages of the size and typography commonly used by other engineering periodicals. Ours is the same size of type and type-page as that of The Literary Digest—easily read, yet giving a large volume of reading matter per page. Our 28 pages of articles would fill 112 pages of the standard 6x9 in. text-book. It would take 10 such books of 580 pa es each to hold all the articles printed each year in Engineering and Contracting, to say nothing of our weekly construction news.

[illegible] engineer who [illegible] to his [illegible] reading [illegible] and [illegible] It seems [illegible] for a few years. But if he secures an insufficient advance in income, even [illegible] to cease [illegible] his self education, society at large and his employer do suffer. They, indeed, are the greatest sufferers. Why, then, should [illegible] that he spends in studying engineering? It will no longer suffice to reply [illegible] adequate pay through promotion to higher positions. Most engineers know that the studious engineer rarely receives the remuneration that he merits. No, payment for studying engineering after graduation should be direct and immediate, [illegible] future.

If, during the 8-hour working day, 7.5 hours were spent by every engineer in routine work, and half an hour in systematic study of current engineering literature, who can doubt that the efficiency of engineers as a class would be greatly increased? Certainly no experienced engineer who travels and observes will deny that there is a vast deal of poor design and poor construction that is attributed to nothing else than ignorance of facts already in print. Of course the same holds true to an even greater degree of the work done by men that are not engineers. Failure to study what other men are doing is a universal failure, and is most pronounced among partly educated men.

Next to bad mental habits, the greatest bar to human progress is failure to study what other men are doing and have done. Yet the very employer who will most quickly grant this proposition, is apt to be most slow in seeing its application to his own business, and will repel any suggestion that he pay his employes for time spent in study. Even experienced engineers are prone to balk at the suggestion that engineers under them should be required to study during office hours. "Let them do their technical reading on their own time, if they are ambitious; and if not ambitious, let them get out of the engineering profession." Is that the right attitude? Is it a truly economic attitude? Think it over. Much may depend upon your conclusion.

Why Waterworks Improvements Should Be Undertaken on a Large Scale

Fifteen years ago the average annual wage of employes of the U. S. Steel Co. was $677. In 1918 it averaged $1,605; and in December, 1918, the average was at the rate of $1,950 per man per annum. In 1914 the average was $857. Hence the great steel company since the war began has more than doubled the average wage paid to its employes.

The price of steel has just been reduced about 12 to 15 per cent, without any reduction in wages. Any further reduction in price does not seem to be in sight. If the efficiency of workmen increases, prices of steel will come down, but that will occur over a relatively long period of time and not suddenly.

Water works departments should cease holding back on extensions and improvements in the hope of securing lower prices. To begin with, it is a public duty to go ahead with construction so as to give employment to ex-war workers and discharged soldiers. Furthermore, high wages are here to stay. Steel and iron prices are now established for the rest of 1919. These prices may recede slowly after this year, but only as the cost of production falls through the use of more economic methods and appliances.

Since most of the material used in water works construction, inclusive of engines, boilers, pumps, pipes, etc., is iron and steel, there should be no more waiting for prices of materials and machinery to fall. Recent annual reports of certain water works departments, however, speak in a doubtful way about going ahead with needed improvements. These reports were written before the Federal Government and the iron and steel manufacturers had agreed upon schedules of lower prices. Prices are now established and wages are not likely to recede. Let there be no more hesitancy in beginning water works construction on a large scale.

For about three years there has been a great reduction in normal expenditures for water works. In the meantime the population has continued growing until most cities have water plants that are now inadequate. Many lack standby engines, boilers and pumps. Still others are using equipment that is obsolete. Let there be a general investigation of the needs of every city water works by competent civil engineers. Then let local engineers' clubs and societies make it their business to get action along the lines recommended

A 20 By 50-Foot Garden Will Supply a Family

Many of the large daily newspapers are printing articles on backyard gardening. They have learned that there is a demand for information of this sort. Water works superintendents would do well also to cater to this demand by sending out bulletins on gardening to water customers. The judicious use of water for garden irrigation is profitable to every one that owns a garden, and should become profitable to any water department.

J. H. Prost, in the Chicago Daily News, says:

"A friend of mine, a banker living in a suburban town, has for years grown all the vegetables a family of three ate during the season in a garden about 30 ft. wide and 35 ft long, and he will permit no one to help him do the work in his garden. In this garden he grows about 22 varieties of vegetables, and never have I tasted better lettuce, beans, egg plant, tomatoes or sweet corn than he grows in this small yet productive garden.

Brown in Chicago Daily News.

His Hat Is in the Ring.

"A piece of ground 20 ft. wide and 50 ft. long will supply a family of four with fresh vegetables during the entire growing season.

"And a piece, say about 50x100 ft., if properly planted, will grow a surplus sufficient to give you vegetables for every day in the year, if you can dry, salt or store the surplus.

"Chicago, I believe, could come pretty close to feeding herself by putting the extra daylight hour to work on the available vacant land now unproductive to growing vegetables."

Since an hour's work daily will supply a city family with vegetables, it is apparent that one who puts in an hour in this manner receives a liberal wage for his service.

A Splendid Article on the Application of a Bonus System

Any system of paying employes that increases their output and their wages merits the careful consideration of every engineer and manager. Often a bonus system successfully applied in a field quite different from your own serves to open your eyes to hitherto unseen economic possibilities. Apropos of this, if the reader, whatever his occupation, will study a bonus payment system described elsewhere in this issue, there is strong likelihood that he will glean some useful suggestion. It may be that he will see how he can apply the "bonus dial," an ingenius daily record of the efficiency of each "shift" or gang. Or it may be that the plan of exciting rivalry between gangs will be suggestive. Such an article can not fail to stimulate thought about managerial methods.

This particular "bonus system" was devised by an engineer, B. H. Blaisdell, of whom the vice-president of the Manila Electric Ry. and Light Co. says: "The company is justly proud of Mr. Benjamin H. Blaisdell, Chief Engineer of Power Plant, for the success of the operation of the bonus system of wages for power plant employes."

Well may the company take pride in a chief engineer who has been able to reduce coal consumption 25 per cent, without any extensive alterations of the plant.

Mr. Blaisdell's article should be particularly suggestive to all who are in charge of water works or irrigation pumping plants, whether small or large. But the usefulness of the article is not limited to any class of our readers.

A Great Socialistic Experiment in England

What has been called "British labor's magna charta" is apparently about to be signed by the British government. As presented by the representatives of organized labor and capitalists the document, in its outstanding proposals, is as follows.

The legislative enactment of a nation-wide normal working week of forty-eight hours for all employes.

The legislative enactment of a nation-wide minimum wage.

The recognition of the trades unions and the employers' organizations as the basis for negotiations between capital and labor.

The prevention of unemployment and the maintenance of unemployed workers.

The creation of a permanent national industrial council of representatives of employers and employes to consider and advise the government of national industrial questions.

Of these five proposals, the fourth is perhaps the most radical. Certainly it is the one that will be most difficult to put into practice without resulting in labor inefficiency. If every worker must be given employment, how is discipline to be maintained? Shirkers need not fear discharge for shirking, because another job must be found for them around the corner. This is only one of many difficulties to be overcome.

On the other hand, some such protection against unemployment may be necessary in Great Britain, if opposition to the introduction of labor saving methods and machines is to be overcome. In a recent editorial we suggested that government protection against unemployment may become universal. If so, workers will have to submit to a good deal of government interference with what has hitherto been called "sacred personal liberty." For example, if a development in wireless telegraphy were to make uneconomic all telegraphy by wire, many thousands of men would lose their jobs. In order to find new work for them, the government might require them to enter training schools to learn new trades. It is likely that they would be required to learn the trade specified by the government. Otherwise overcrowding of popular trades would result. How will "free born Britains" take to the idea of losing a lot of their freedom? Will they submit to being told what trades they must enter?

Should Great Britain nationalize the coal mines and railways, as demanded by employes in those industries, and should the "labor magna charta" be adopted, two decided steps toward state socialism will have been taken by nearly half the English speaking people of the world. What will the effect of this example be upon the other half? Will Americans be sensible enough to watch the results of the great English experiment before undertaking it themselves? Scientific men make an experiment on a small scale before trying it on a larger scale. But the average American is neither a scientist, nor does he understand scientific methods—more's the pity—and we may find ourselves also plunging into a huge socialistic experiment before we have had half a chance to see how well it works abroad.

1919 Convention of American Water Works Association.—The 39th annual convention of the American Water Works Association will be held June 9-13 at Buffalo, N. Y., with headquarters at the Iroquois Hotel.

Certain Illogical Tests of Intelligence

By HALBERT P. GILLETTE,

Editor, Engineering and Contracting.

Prof. James, in his "Talks to Teachers on Psychology," began by warning against certain fads and fancies, the pseudo-psychology of his day. There are always numbers of men who seize upon and exploit for their own profit every new science. Usually they are not in the least bit scientific themselves, but they ape the ways and the words of scientists so skilfully that they are often able to pass for men of learning. During the past decade we have seen and heard a host of such mimics—pseudomorphs, they would be called were they minerals—who have termed themselves "efficiency engineers." Men who were neither engineers nor efficient, who could not even properly define science, efficiency or engineering, have been posing as "fathers" and "pioneers" of the science of management. Small wonder that they have almost brought "efficiency engineering" and "scientific management" into disrepute.

Applied psychology is a new science that seems fated to pass through a period of charlatanism analogous to the period from which "scientific management" is just emerging. "Epoch making" books on Character Reading, Will Power, Memorizing, etc., are being widely advertised. The advertisements alone should suffice to put a thinking man upon his guard, so extravagant are the claims; but most men, even among the so-called educated classes, are not trained to think, and are therefore easily taken in by specious argument and spacious assertion.

During the last 12 years more than 2,000 books on business matters have been published in the English language. These were preceded by countless articles on management, accounting, "system," etc., etc. We are now beginning to see so many articles on applied psychology that it will not be surprising if 2,000 books on the subject appear within the next decade. Engineers can no more afford to ignore the current literature on applied psychology than that on scientific management. But if they wish to conserve their time they must learn how to discriminate between the good and the worthless. As a first step in acquiring a faculty of discrimination, it is well to study at least one or two books on logic, such as Bains or Jevons. The next step should be to adopt a suggestion that Molesworth made about "engineers' pocketbooks"—write your own. In short, analyze the reasoning methods used by others as well as by yourself.

An engineer, being trained to use mathematics, knows that before he can calculate the combined effect of different energies, he must reduce them to a common unit. He knows that 100 horsepower can be added to 10 British thermal units per second, only by converting H.P. to B.T.U. per sec., or vice versa. An engineer knows that 100 H.P. plus 10 B.T.U. per sec. does not make 110 units of any kind whatsoever. Yet the same engineer will probably read without criticism an article in which a military officer is "rated" thus:

Physical qualities	9
Intelligence	12
Leadership	[illegible]
Personal qualities	[illegible]
General value to the service	[illegible]
Total rating on scale of 100	67

In this issue of Engineering and Contracting there is an abstract of an article that appeared in the American Magazine, entitled "How High Do You Stand on the Rating Scale?" It contains much fulsome praise of the psychological tests used in rating officers during the recent war. Read that article. When you come to the place where "Ralph Jones" is rated as a 67 per cent ideal officer, by adding together his ratings under each of five heads, ask yourself how it is possible to add 9 units relating to "physical qualities" to 12 units relating to "intelligence." Stop right there. Do not let yourself be confused by the use of "units" to which you are unaccustomed. Remember that you can not add a per cent of a full barrel of cement to a per cent of a full car load of sand, and get a per cent of anything in particular. Consider, then, that you can not add physical qualities to mental qualities, any more than you can add the hardness of quartz (in the scale of mineral hardness) to the height of a mountain.

In Engineering and Contracting of January 31, 1917, I pointed out that Prof. C. R. Mann's report on the study of engi-

[illegible] as the fallacy of rating incommensurables in an [illegible] order of importance. Nearly every quality [illegible] here [illegible] as engineers, [illegible] the reasons for [illegible] the most notable values [illegible] qualities." Prof. Mann [illegible] theory of [illegible] with the following result [illegible] engineers.

[illegible]

I need not repeat my [illegible] of the false logic [illegible] mathematics. But it may [illegible] of the fact that [illegible] to do the impossible [illegible] order of importance to the six "qualities" above named. What is the relative importance of the heart and the brain? Ask such a question of any man and he will think you are jesting. But merely change your question a trifle, and he receives it in seriousness. What is the relative importance of character and knowledge, asks Prof. Mann, and nine out of ten engineers answer by placing character ahead of knowledge. We need not look long for the reason that led to this rating. Character is mainly inherited and only partly acquired. Knowledge is entirely acquired. Since what comes first in order of time is apt to be regarded as first in order of importance, character is apt to be given preference over knowledge in answering a question as to their relative importance. However, the question was not intended to establish a rating based on any order of appearance of the qualities named; it was intended to ascertain the relative importance of all the qualities at any given [illegible] with a given character and a certain fund of acquired knowledge. Compare him with other men both as to character and knowledge, and state his relative standing. My answer is it can not be done by adding together incommensurable units.

Where two kinds of energy combine to produce a given result, neither one can be rated above the other; both are [illegible] to express both kinds of energy in the same unit, and then rate them quantitatively. [illegible] will unite if a certain amount of heat is applied to them. The two chemicals and the heat are equally essential to produce the reaction or effect. But the number of thermal units ascribable to each of the two elements may be ascertained, and their relative contribution to the total heat of combination may be calculated. Some such calculation of the relative number of mental units in [illegible] possibly be made by psychologists a century hence, but not until that is accomplished will it be rational to rate "character" at 24 and [illegible] by Prof. Mann. Any such rating is really nonsense, and it stands on all fours with the psychological rating of army officers above referred to.

In Prof. Lewis M. Terman's book on "The Measurement of Intelligence" the claim is made that the best single test of intelligence is the "vocabulary test." An abstract of a review of this book is given in an article in this issue, from which the reader may judge the nature of this test. It is claimed to give results approximating those obtained by applying the Binet-Simon psychological tests. This may be true, but if the Binet-Simon tests are not satisfactory, the vocabulary tests can not be more so.

It is evident that a vocabulary test will indicate, to a considerable extent, the tenacity of memory and the range of reading, and the habit of defining words. All these are indicative of mental power, but there is vastly more to "intelligence" than these three factors.

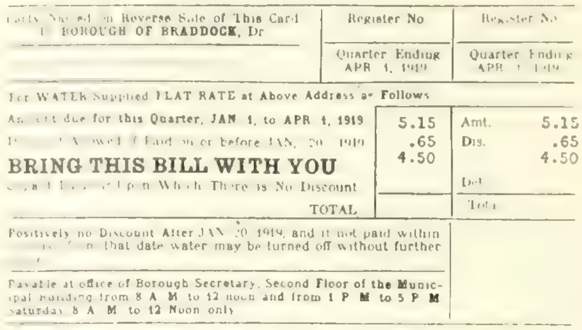
I do not wish to convey the impression that I am opposed to psychological tests. What I am opposing is the extreme claims that are being made for these short-cut methods of "sizing up" men. In doing so I have incidentally pointed out one of the gravest of fallacies, namely the assigning of quantitative values to incommensurable qualities, and then using these quantities as if they related to common units of measure. I have yet to see a rational defense of such a procedure.

Columbia College, it has been announced, is about to adopt psychological tests and abandon ordinary examinations for [illegible] To put it mildly this is a radical experiment. It may prove to possess merit, but I venture to predict that psychological tests alone will not suffice in selecting the fittest applicants for admission to college.

Labor Saving Method of Handling Water Consumers' Accounts

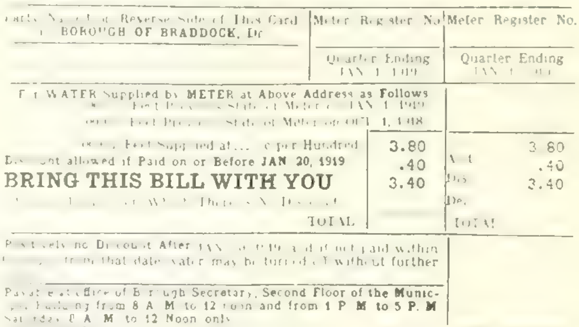
An ingenious system for handling water consumer accounts is employed by the Water Department of Braddock, Pa. Bills are mailed out quarterly and are subject to discount if paid on or before the 20th of the month. If the bills are not paid by that time a "10 day final notice card" is sent out. If the bills are not paid at the expiration of this limit, the water service is shut off.

Two lists of stencils are kept, one for consumers on flat rate and one for those on meters. In the case of the flat rate the stencil bears the name and address of the consumer and the amount of his bill for the quarter together with the discount. A card (Fig. 1) is then run twice through the addressing machine which puts the address on one side and the amount of the bill in duplicate on the other. When the customer comes in to pay his bill, which he must bring with him, it is marked "Paid" by a stamping machine which cuts off the right hand portion and drops it into a box. This portion then acts as a record of the payment of the account and at the end of the day's work is transferred to the ledger. The sum of these also gives the receipts for the day. For the meter customers, the same scheme is used except that of course in this case the meter readings must be added to each card by hand. The coupon cutting machine for clipping the end off the cards is very similar to those in use by the various gas and electric light companies throughout the country. With one operation the machine automatically clips the end and marks "paid" on the card and coupon, which falls into the machine.



[illegible] on Reverse Side of This Card
[illegible] BOROUGH OF BRADDOCK, Dr
Register No
Quarter Ending APR 1, 1919
Register No
Quarter Ending APR 1, 1919
For WATER Supplied FLAT RATE at Above Address as Follows
Amount due for this Quarter, JAN 1, to APR 1, 1919 5.15
[illegible] if Paid on or before JAN. 20, 1919 .65
4.50
BRING THIS BILL WITH YOU
[illegible] Upon Which There is No Discount
TOTAL
Amt. 5.15
Dis. .65
4.50
Del.
Total
Positively no Discount After JAN. 20, 1919, and if not paid within [illegible] from that date water may be turned off without further [illegible]
Payable at office of Borough Secretary, Second Floor of the Municipal Building from 8 A. M. to 12 noon and from 1 P. M. to 5 P. M. Saturday 8 A. M. to 12 Noon only

Fig. 1—Card Used With Flat Rate.



[illegible] on Reverse Side of This Card
[illegible] BOROUGH OF BRADDOCK, Dr
Meter Register No.
Quarter Ending JAN 1, 1919
Meter Register No.
Quarter Ending JAN 1, 1919
For WATER Supplied by METER at Above Address as Follows
[illegible] Feet Present State of Meter on JAN 1, 1919
[illegible] Feet Previous State of Meter on OCT 1, 1918
[illegible] Feet Supplied at.... c per Hundred 3.80
[illegible] allowed if Paid on or Before JAN 20, 1919 .40
BRING THIS BILL WITH YOU 3.40
[illegible] Upon Which There is No Discount
TOTAL
3.80
Amt .40
Dis 3.40
Del.
TOTAL
Positively no Discount After JAN. [illegible] and if not paid within [illegible] from that date water may be turned off without further [illegible]
Payable at office of Borough Secretary, Second Floor of the Municipal Building from 8 A. M. to 12 noon and from 1 P. M. to 5 P. M. Saturday 8 A. M. to 12 Noon only

Fig. 2—Card for Meter Rate.

In order to lessen the labor of adding the amounts, a series of stencils has been cut giving these amounts properly figured out with discounts for each 100 cu. ft. of water consumed. Then the bills are grouped according to amounts, are run through the machine, and those having the same amounts are stenciled accordingly. This results in a great saving of time and labor over having to add these amounts by hand. When bills are paid they are handled the same as those for flat rates. The system described was developed by Mr. W. H. Williams, Director of Public Works and W. P. Conway, Borough Secretary, to whom we are indebted for the above information.

Water Softening: Investigation; Features of Plant; and Special Problems of Large Installations*

By M. F. STEIN,
Civil Engineer, 653 Lafayette Ave., Chicago, Ill.

The Process of Water Softening.—On adding slaked lime to a hard water, the following reactions take place:

(1) $Ca\,CO_3, H_2\,CO_3 + Ca(OH)_2 = 2\,Ca\,CO_3 + 2H_2\,O$

(2) $Mg\,CO_3, H_2\,CO_3 + Ca(OH)_2 = Mg\,CO_3 + Ca\,CO_3 + 2\,H_2\,O$

(3) $Mg\,CO_3 + Ca(OH)_2 = Ca\,CO_3 + Mg(OH)_2$

In equation (1), the calcium carbonate formed is only soluble to the extent of about 13 p.p.m. and so precipitates out. The magnesium carbonate in equation (2), being soluble to the amount of about 100 p.p.m remains in solution to that extent, and requires additional lime for its removal as the insoluble hydroxide. At least this is the theory, but in practice such ideal conditions do not obtain. The solubility of the calcium carbonate as precipitated from a solution seems to be greater than the amount which can be dissolved by shaking it in the powdered form with water. The presence of magnesium carbonate effects the solubility of calcium carbonate, as there appears to be a definite limit to the combined solubility of the two salts. The presence of other compounds, particularly sodium chloride, tends to increase these residual solubilities, and they are also affected by the temperature of the water. The magnesium hydroxide in equation (3) forms very slowly and is apt to assume a colloidal condition, and to return to its former state by absorbing carbonic acid from the air.

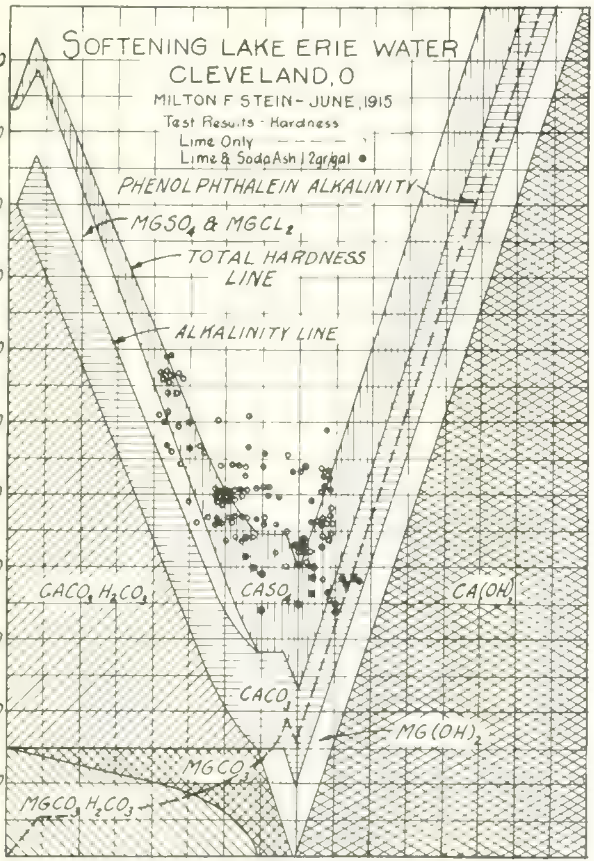


Fig. 1—Results of Investigation on Softening Lake Erie Water.

If either the sulphate or chloride of magnesium is present a further reaction takes place:

(4) $Mg\,SO_4 + Ca(OH)_2 = Mg(OH)_2 + Ca\,SO_4$

As will be seen, this consumes lime uselessly, since the calcium sulphate formed is the most troublesome kind of permanent hardness, and the magnesium hydroxide will probably remain in colloidal solution.

Results of Investigation for Softening Lake Erie Water.—In Fig. 1 are shown graphically some of the results of an investigation on softening Lake Erie water at Cleveland, O. This diagram purports to show the ultimate composition of the water after treatment with various amouns of lime, and on the assumption of a very long reaction period. The vertical scale gives alkalinity and hardness as p.p.m. of calcium carbonate. The horizontal scale shows the amounts of lime added, in grains per gallon. It shows that the hardening constituents of this water consist of 15 p.p.m. magnesium bicarbonate, 75 p.p.m. calcium bicarbonate (these, combined, giving the water an alkalinity of 90 p.p.m.) and magnesium sulphate and chloride to the extent of 13 p.p.m., making the total hardness 103 p.p.m. Treatment with approximately half a grain of lime results in an increase of hardness, since the calcium carbonate formed is less than the saturation value and remains in solution. Larger quantities of lime result in progressively decreasing hardness. It will be observed that the lime reacts with the hardening constituents in proportion to their amounts, and that only that part of the lime which combines with the calcium bicarbonate does effective work, since in the case of magnesium bicarbonate, the soluble monocarbonate is formed, and the magnesium sulphate is replaced by the more objectionable calcium sulphate. By adding as much as four grains of lime some of the monocarbonate of magnesium can be precipitated as the hydroxide, in theory at least, while more than four grains causes an increase in hardness again. A judgment based on this diagram would place the optimum amount of lime at about three grains, which was borne out by the results of numerous large scale tests at the Cleveland experimental plant.

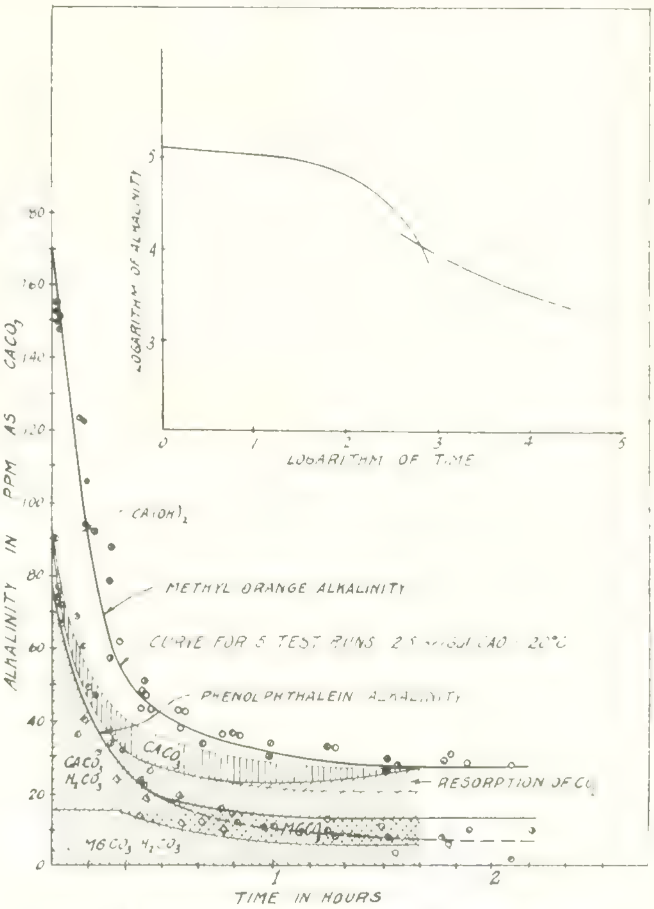


Fig. 2—Experimental Results with Cleveland Water

Lake Erie water lends itself particularly to such a diagrammatic representation because of its constant composition. For most waters, a series of diagrams or a model would be necessary owing to variation of the constituents.

Experimental Results at Cleveland, O., with Lake Erie Water.—The rate of reaction in water-softening is quite slow. Some experimental results obtained with Cleveland water are shown in Fig. 2. The dots show the results of

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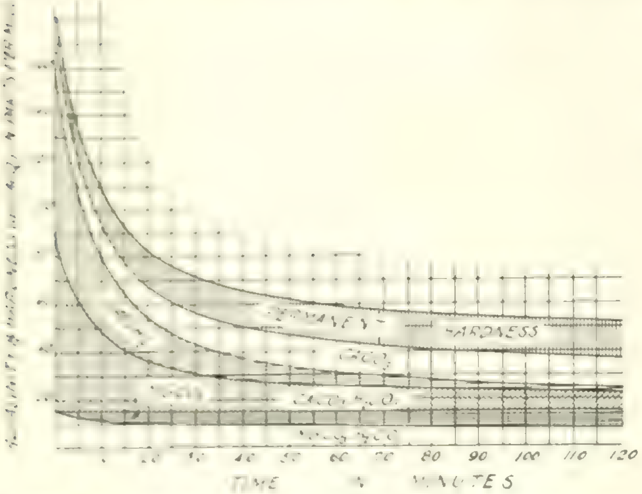
*Abstract of a paper presented March 25 at the 11th annual meeting of the Illinois Section of the American Waterworks Association.

[illegible] and with [illegible] and [illegible] ascertained by titration at [illegible] of the points shows that [illegible] of the reaction. [illegible] it is possible [illegible] as shown by the shaded [illegible] by the diagram [illegible] of the values as shown by the [illegible]. There is a very evident break in the continuity, slope and curvature of the line at a point corresponding to [illegible] of Alkalinity [illegible]. This [illegible] taking place in two steps, first,



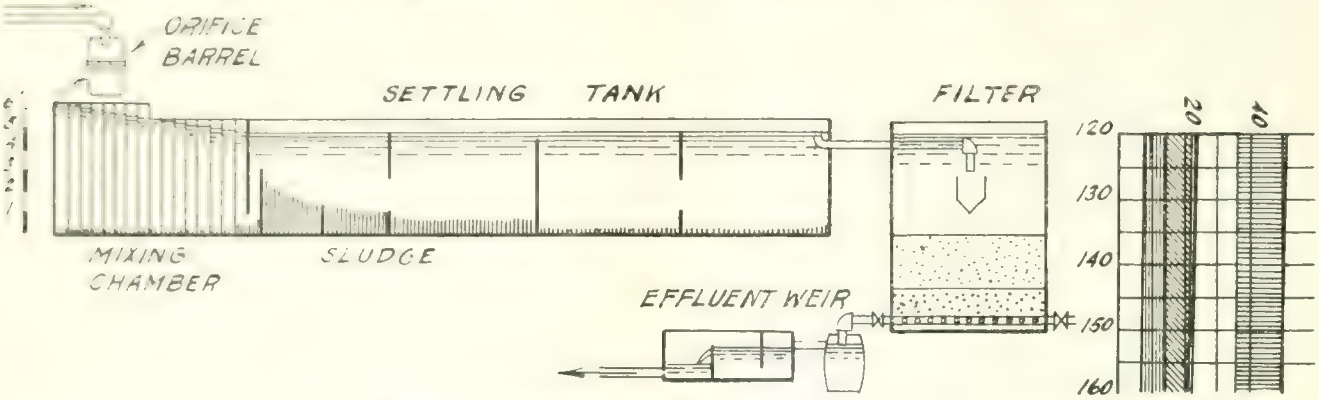


Fig. 3.—Progressive Softening Reaction in Cleveland Testing Plant.

the reaction of the lime with the calcium salts; second, with the magnesium salts. The same thing may be noticed in connection with the soap test as applied to water containing both calcium and magnesium compounds. There is a false end point when the calcium compounds have been displaced, followed later by the true end point when the reaction with the magnesium salts is completed. In all cases the magnesium compounds seem to be more sluggish in action.

Figure 3 shows the progressive softening reaction which took place in the Cleveland testing plant. The incoming water was measured by an orifice barrel, the lime solution being proportioned to it by a float operated device. It then passed through an up-and-down mixing chamber into a settling tank. The depth of sludge deposit in the settling tank is indicated. From the settling tank it passed through a mechanical filter of the usual type. There was usually a drop in alkalinity in passing through the filter, due to the precipitation of colloidal magnesium hydroxide and probably calcium carbonate by contact with the sand, as well as to a continuation of the softening process. There was some incrustation of the sand, as well as on plain and galvanized iron plates which were exposed continuously for 5 months in a stream of the softened and filtered water. This question of after-deposits is a serious one, and requires special study in individual cases. It causes trouble in the filter sand, under-drains, controllers, in meters, if galvanized in- [illegible] employed [illegible] limit [illegible] a margin of safety is allowed, probably stopping just short of where the magnesium reaction begins. The addition of a coagulant during the latter portion of the settling period seems to act as a preventive.

The question of temperature in connection with the reaction period should be mentioned. The temperature factor in chemical reaction velocities is still a debated point. No formula of general applicability has yet been devised. In many cases the reaction velocity doubles for every 10° C. rise in temperature. Since the data heretofore considered was obtained at about optimum temperature for large scale water softening in the temperate zone, viz.: 20° or 68° F., this would mean that for a 4-hour reaction period, an 8-hour period must be substituted at 10° C., or a 16-hour period at 0° C. Besides this, there seems to be a sort of inertia to the reaction starting at all in extremely cold water, which is very discouraging at times.

Nothing has been said as yet regarding the use of soda ash for removing permanent hardness. The equations are:

(1) $CaSO_4 + Na_2CO_3 = CaCO_3 + Na_2SO_4$,

(2) $MgSO_4 + Na_2CO_3 = MgCO_3 + Na_2SO_4$.

The reaction is sluggish when carried out in the cold. When the permanent hardness is low or is due to by-products of the lime process, the amount of soda-ash required is small and according to the law of mass action, the rate of reaction will be very slow. The magnesium carbonate formed in the case of magnesium salts is quite soluble and remains in solution. It will thus be seen that the use of soda ash in softening municipal water supplies is on a much more precarious basis than in the case of boiler feed waters, and should not be entered upon without careful study and serious consideration.

The Essential Features of a Softening Plant.—In the light of the foregoing and from other experience the requisites for carrying out a water-softening project successfully may be given.

1. There should be a very thorough analytical and experimental investigation which should cover particularly:

a. Analyses of the water in question and the variations to be expected therein.

b. The amount of reagent which can be successfully applied without causing trouble from after-deposits and incrustation. It is suggested that special attention be given to the point where magnesium reactions commence.

c. The question of whether it is advisable to attempt the removal of permanent hardening constituents in view of the additional burden which the use of soda ash involves.

d. The determination of the reaction period required under conditions of minimum concentration of reagent and minimum temperature.

To interpret experimental data in terms of practical working conditions requires special experience based on contact with both phases of the problem.

2. There must be an understanding on the part of the municipal authorities that to accomplish its task a water-softening plant must be adequate throughout, and that there can be no skimping in the size of parts or in equipment or in operating expenses if satisfactory results are to be obtained. This holds more rigidly in the case of softening plants than in the case of ordinary water purification plants.

3. The principal design features of a water-softening plant should include:

a. Mixing chambers in which the softening reagents are thoroughly dispersed through the raw water, either by mechanical devices or by baffling. This mixing action also seems to accelerate the reactions.

b. Large settling basins, whose capacity is based upon the reaction period as determined for conditions of minimum temperature. These basins will generally be several times as large as would be required for the regular type of purification plants.

c. Means for adding a coagulant solution either at the entrance to or near the exit from the settling basins, or at both points, to assist in starting and completing the softening reaction.

d. Mechanical filters of the usual type.

e. Special apparatus for properly slaking and feeding the lime solution into the water. Due to the tendency of lime carbonates to settle and to choke feed piping, this portion of the design requires particular care and study.

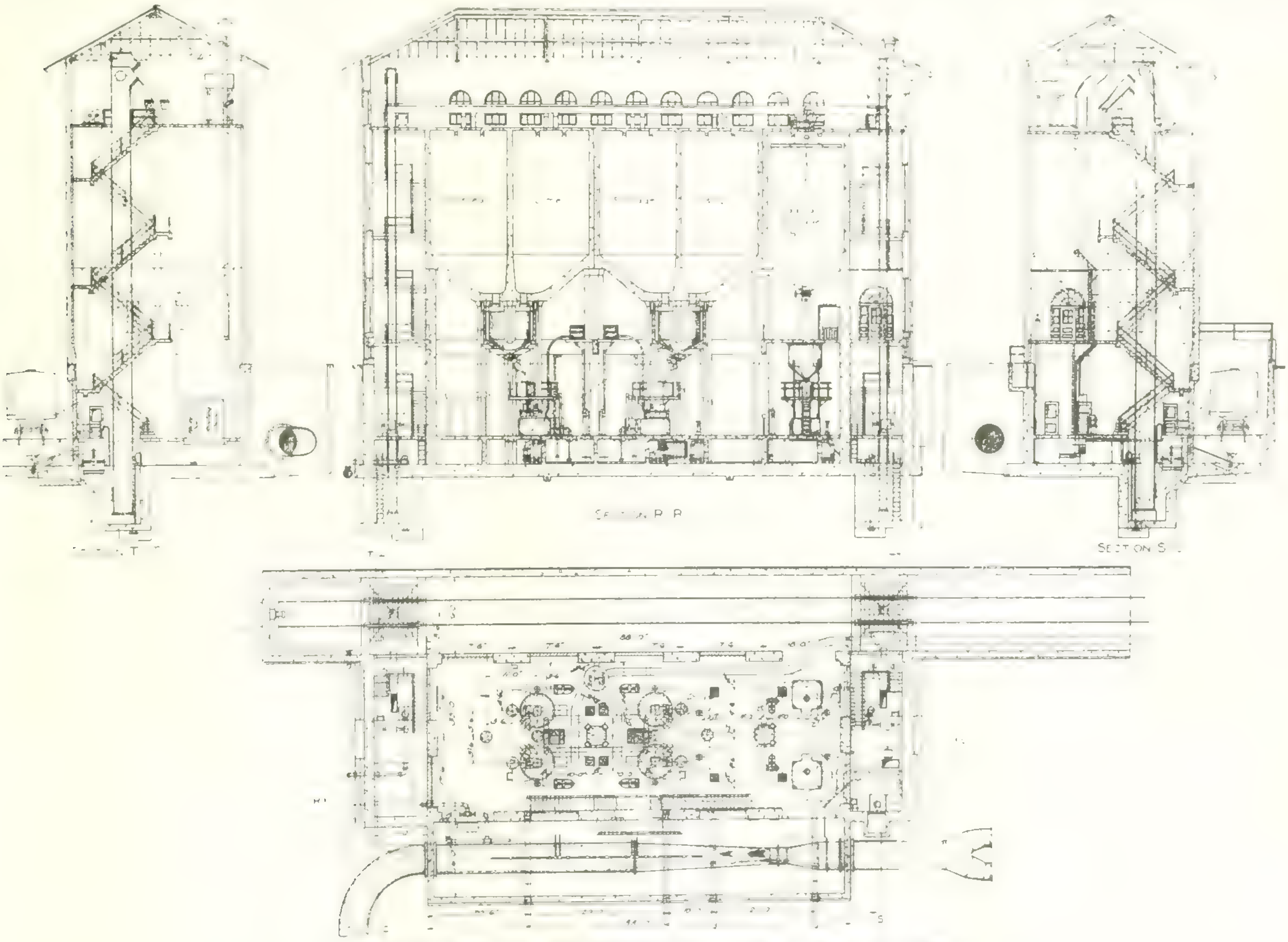


Fig 4—Arrangement of Chemical House at the Cleveland Plant.

Special Problems of the Large Softening Plant.—It is needless to give a description of the details of municipal water-softening plants of small or moderate size, since they conform so closely, except as to relative proportion of parts, to the usual type of mechanical filter plants. In the case of large installations, however, there have been certain special developments which may not be without interest.

The settling basins will be quite large. The precipitate obtained will be voluminous, and special provision must be made for its frequent and expeditious removal. This requires that the settling capacity be divided into a number of units, and that at least one spare unit be provided so that cleaning will not interfere with the operation. Frequent clean-out valves must be placed in the floor of the basins. In the experimental plant at least three-fourths of the sludge collected in the first few feet of the settling tank, in fact it occasionally happened that this portion of the tank almost filled up in a week's time. It appears to the writer that the first quarter-length of the settling basins should be made deeper than the remainder and equipped with automatic sludge removers of the continuous type, such as "Dorr thickeners."

Since the sludge is composed essentially of the lime added to the water and an equal amount abstracted from the water both in the form of calcium carbonate, it has been suggested that this sludge be reburned, thus recovering not only the lime added, but an equal amount in addition. Mr. C. P. Hoover tried this experimentally at Columbus on a considerable scale, and small scale experiments were made at Cleveland. The product is about 75 per cent water soluble CaO, and slakes readily. The writer made some preliminary studies for such a lime recovery plant, which included resettling tanks, special centrifugals and rotary kilns fired with producer gas. The estimated cost of reburned lime is about 75 per cent of that for commercial lime, based on available CaO. The reburning plant is quite a separate institution, requiring operators with a different type of training and experience. It is a manufacturing proposition, and those from present experience, do not lend themselves readily to municipal control. For this reason, and because the product is less easily handled, the advantages and disadvantages seem very evenly balanced.

Methods of Handling Chemicals at Cleveland Plant.—Perhaps the most interesting phase of a large water-softening installation is the handling of the large quantity of chemicals used. Thus the Cleveland plant, operating at its capacity of 150,000,000 gal. daily, would require about 40 tons of lime per day. The arrangement of the chemical house is shown in Fig. 4. The lime arrives in box cars, via a depressed siding on one side of the building. It is shoveled into a chute by means of power shovels, and falls into a crusher. The crushed lime is carried by means of elevator and screw conveyors to overhead storage bins, which have a capacity of 1,500 tons of lime. These bins presented a rather interesting problem in concrete design, owing largely to the heavy load of 1 ton per square feet on the bottom and the peculiar shape required. The reinforcement really constituted a steel basket hung into the walls of the bin.

It will be seen from Fig. 4 that each four bins connect into one daily hopper and from this the lime flows by gravity to automatic scales. The discharge of the scales can be automatically controlled to conform to the pumpage of raw water by means of the venturi meter in the raw water line which passes through the chemical house. I have made a rough diagram of this device (Fig. 5). From the raw water [illegible] float tubes in the usual man-ner [illegible] differential scale cams [illegible] so that the [illegible] is directly proportional to the flow through the meter. A [illegible] counterbalance [illegible] to a traveling carriage [illegible] backward and forward on [illegible] friction disk driven [illegible] motor. Mounted on the carriage is a small contact wheel. With no flow, the position of the carriage brings this wheel to the center of the disk [illegible]. As the flow increases the carriage shifts and the contact wheel moves faster and [illegible] this wheel closes an electrical contact [illegible] actuates the auto-matic [illegible] to discharge. These scales are [illegible] entirely disguised by aux-

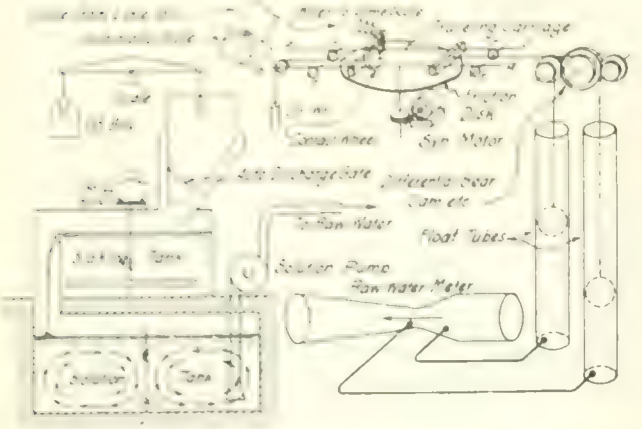


Fig. [illegible]—Device for Automatic Control of Discharge from Scales.

[illegible] complications. As soon as a scale is tripped, the automatic discharge gate opens and the lime flows out, very quickly. This unbalances the scale beam, which tilts up, and in so doing closes the discharge and opens the feed gate. The feed gate, of the under-cut type, is gradually closed as the scale pan fills up and shuts off entirely when the predetermined amount has been reached. The scale is then ready to be tripped again by the contact wheel.

The scales discharge into slaking tanks, where the lime is slaked with hot water, and agitated by motor-driven paddles. The slaked lime overflows into solution tanks where it is cooled and diluted with water, and is then pumped into the raw water.

The coagulant, either ferrous sulphate or alum, is handled in a similar manner, with minor modifications.

The Cleveland work was designed and built under the direction of Mr. R. Winthrop Pratt, Consulting Engineer; Mr. Frank H. Stephenson, Designing Engineer, the work being in immediate charge of the design of the portions herein described. The automatic scales were furnished by the Richardson Scale Co. The proportional feed device was built by the Builders' Iron Foundry, from sketches furnished by the writer.

Sanitary Sewer Statistics of Newton, Mass.—At the end of 1918, Newton, Mass., a city of 43,113 population by the 1915 census, had 130.38 miles of sanitary sewer. The total area of the city is 18 square miles, and the estimated population served is 40,000. In all 7,688 buildings are connected to the system. The system, according to the last annual report of E. H. Rogers, City Engineers, comprised 55,660 lin. ft. of brick sewer, 4,969 lin. ft. of concrete sewer, 627,768 lin. ft. of vitrified pipe sewer, 87 miles of permanent underdrains, and 3,359 manholes. In addition there were 280 direct connections with water mains for flushing. The total length of house connections, 5 in. and 6 in. in size, is 99.37 miles. The total cost of the connections is paid by the abutter. The average cost is $1.25 per lineal foot. The total cost of the sewer system is $2,303,301. The sewage is discharged into the South Metropolitan sewerage system. The city's payments in 1918 for this service were: maintenance Metropolitan sewer, $15,025; sinking fund, Metropolitan sewer, $9,254; interest for Metropolitan sewer, $40,799.

Prevention of Water Waste and Reasons for Metering

New meter rates were put into effect last year by the Spring Valley Water Co. of SanFrancisco. The company has approximately 65,000 services, all of which are metered. In introducing the new system of charges the company supplied to each customer a pamphlet setting forth the reason for the changes and pointing out the advantages. Extracts from the pamphlet follow.

Necessity for Prevention of Waste.—To meet the present urgent needs of the city and to prevent a possible future shortage, San Francisco's supply of water must be carefully guarded. The present sources of supply are now drawn to their full capacity, and, unless some of this supply can be saved, additional water must be secured. An additional supply can only be secured by building an additional pipe line to the city and after the pipe line is commenced, it will take three years to complete it. It is impossible to build this pipe line now, because necessary labor cannot be secured, and steel plate and other materials absolutely essential in this construction are required by the United States Government. This means that for the next few years San Francisco must depend upon its present developed supply, and every effort must be made to make that supply sufficient to meet the city's needs. If this is not done, San Francisco will be short of water.

There is one way in which such a disaster can be prevented and there is only one way. It involves the elimination and prevention of waste. Waste of water can be dealt with effectively only by installing water meters. The California Railroad Commission has recognized these facts and has directed this company to install meters. The necessity for installing meters is recognized by every public authority conversant with the situation. This includes the city engineer, the engineers for the Railroad Commission, and the Railroad Commission itself.

Reasons for Meters.—There are two reasons for installing water meters. First: Their use directly reduces waste. When there is a meter on each service pipe, the party carelessly or wilfully wasting water is made to pay for it. Second: Meters prevent discrimination. When they are used the consumer pays only for what he gets and the company is paid duly for what it supplies.

The old rates commonly called flat rates were unfair. Under them you did not pay for water actually used, but bills were necessarily based on the water which you were supposed to use. This resulted in some consumers paying much more than they should have paid, and in others paying much less. There was no incentive to save and waste necessarily followed.

Most people are careful in the use of water. There are, however, a few whose carelessness or deliberate waste increases enormously the amount of water that must be provided. A leaking toilet may easily waste as much water as would serve 20 families. This water costs money to produce. If those who waste it do not pay for it the burden must be borne by all. This results in the public having a heavier burden to bear and each consumer paying a greater charge. This is particularly true in this city because every gallon of water in the street mains has been pumped from one to four times before it reaches its destination. Pumping requires the use of oil. The company used this year over 100,000 bbls. of oil, and the cost of oil has now increased more than 100 per cent.

What the Consumer Pays for.—In supplying water there are three operations:

First: Developing and protecting the water at its source, collecting it in the large storage reservoirs, and pumping and conveying it to the city distributing reservoirs.

Second: Distributing water throughout the city through the main supply lines to the smaller regulating reservoirs, and finally through the distribution lines in each street.

Third: Maintenance and repairs to meters and services, inspection of plumbing and fixtures for the consumers, reading meters, bookkeeping, billing and collecting.

The charge to be made by this company on account of the first two items the Railroad Commission by its ad interim order established. It ranges from 24 ct. for each 100 cu. ft. for domestic and small commercial consumers to 18 ct. for each 100 cu. ft. for large industrial consumers. The reason for this distinction is that it costs relatively less to distribute water in large quantities than in small quantities. At the highest rate a barrel of water costs about one cent.

The third item forms the basis for what is known as the "service charge." This has been fixed by the Railroad Commission at 65 ct. per month for ordinary household meters, and increases through intermediate charges to $40 per month for the large 8-inch connections.

Service Charge.—Each individual consumer pays a specific amount for service rendered to him individually, and the amount which he pays is determined by the size of his service. Unless this is done all these expenses go into the general operating expense account and must be distributed among the consumers without regard to the service to the individual. The service charge is the most equitable arrangement. It is fairer than the "minimum bill" method.

The service charge is not an additional charge and does not mean higher rates. It is simply a different and more equitable way of distributing the cost of service among consumers.

Note that if there is a discontinuance of service, the service charge likewise stops.

The meter rates are ad interim rates. They were put in to prevent waste and to distribute fairly between the consumers the cost of supplying water. They were not put in to increase the company's revenue, and the order of the Commission specifically provides that they shall not do so. The Commission's order says:

"The proposal of the company is fair, to-wit: That the rates now established shall not result in any increased revenue or profit and in the event that through inadvertence or as a result of conditions impossible to estimate accurately, a greater revenue should be produced, all over-plus over present revenue shall be held at the disposition of the Commission for the benefit of consumers."

Effect of Meter Rates.—At least 50 per cent of the company's consumers will pay less than they paid under flat rates. Many consumers will notice no appreciable change in the monthly charges. Others, particularly those whose water is wasted, will pay more than they have paid in the past.

Those who take large quantities of water and who get the wholesale rate will pay more. The old wholesale rate was too low and the Railroad Commission has decided that this class of consumers should bear a larger proportion of the whole cost.

Builders and contractors will pay materially less than under the old schedule. Bills for water service to vessels supplied at open docks will be much less. They were charged too much proportionately under the old rates. Several thousand small stores and shops previously paying the minimum of $1.80 per month will average a saving of between 25 and 50 per cent. By guarding against waste through faulty plumbing and exercising proper supervision of irrigation at least one-half of the residential consumers should reduce their bills.

If your bill is higher than you think it should be look first for waste. If you do not find it see if you are not really using as much water as the bill calls for.

The company maintains a force of experienced plumbing inspectors. This force is at your service and will advise you upon request, free of charge. It is to our advantage, as well as yours, to eliminate waste, and to this end we seek your co-operation.

Boiler Room Measuring Devices.—To deprive the boiler room of measuring devices which show what is going on is as absurd as it would be to deprive the merchant and manufacturer of the yard stick, quart measure or set of scales, stated Prof. Kennerson of Brown University in a paper presented before the Providence Engineering Society. The boiler room should at least be provided with means for measuring water and weighing coal, and in addition it would usually be well to provide means for analyzing flue gases. Large sums of money are spent in the boiler and engine rooms and it is as essential that some system of accounting be installed as in any other part of the plant. Incidentally, this makes possible a bonus system based on fuel saved, which in many cases has worked out well. Entirely apart from such a system, however, the men who run steam plants will, in nearly all cases, welcome the opportunity to know the facts that they may better the conditions.

Air Lift Boosts Artesian Well Flow

By connecting its wells with an air lift system the Clinton, Ia., Water Works Co. was able to greatly increase the artesian flow without altering conditions at reservoir and piping to any extent. The plan is described by Mr. John Oliphant in Mine & Quarry, to which we are indebted for the matter that follows.

The city of Clinton, Iowa, is provided with water for domestic and public purposes by the Clinton Water Works Co., a private corporation of which Mr. W. L. Meager is superintendent. The supply is secured from some half dozen wells, having a surface flow of limited volume. These are connected so as to flow into a surface reservoir or may be direct connected to mains by means of suction pumps.

Experience showed that when suction was resorted to the supply for the summer heat load or an extended fire demand was insufficient. Three of the wells were therefore connected with an air-lift system arranged to discharge into the reservoir, using the suction piping as a gravity flow line.

Flow from 8-in. Well After Connection with Air Lift.

A suitable arrangement of valves is provided to permit this flow from the wells to the reservoir while the service pumps draw their supply from the reservoir by suction. By this arrangement, the water supply was more than doubled from these three wells.

The illustration shows one of the 8-in. wells which had a natural artesian flow of about 150 gal. per minute. When under suction from the pumps, the pull-down was 20 ft., increasing the flow to 500 gal. per minute. When this well was connected up for operation under the air-lift, its production was increased to 1,035 gal. per minute, the pumping head being 50 ft. below the surface. The other two wells connected up in the same manner showed a proportionate increase. The picture shows the 8-in. well being discharged by means of a tee at the surface for flushing and cleaning out. An umbrella head was afterwards placed on this well, permitting discharge into the cement basin, from which the water was conducted by the suction line to the reservoir by gravity.

These wells are handled by means of a Sullivan central air-lift pump, suspended on a 2-in. air line in the 8-in. casing. The air for operating the wells is supplied by a Sullivan straight-line simple steam and compound air compressor, Class WB-2, size 14x16x10x16, having a capacity of 558 cu. ft. of free air per minute. The installation was effected in a simple and economical manner, piping the air from the receiver to and into the wells. On ordinary service, the pumps secure sufficient supply by direct suction. When an increase is demanded by the summer domestic requirements or by fire, it is merely necessary to start the compressor, throw a few valves and the supply from the wells is more than doubled.

Conference of Engineering Societies.—A conference of engineering societies and associations has been called by the Engineering Council for the purpose of taking action toward securing the establishment of a Federal Department of Public Works. The conference will be held at Chicago, April 23-25. Some 152 organizations have been invited to send delegates.

How High Do You Stand in the Rating Scale?*

[illegible] a group of college profes- sors [illegible] psychology [illegible] trade [illegible] they said to each other [illegible] Out of their con- [illegible] out of their meeting [illegible] have been not only [illegible] importance to busi- ness [illegible] These three things are:

The Qualification Card.
The Intelligence Tests.
The Rating Scale.

[illegible] what provision had been made [illegible] personal data about [illegible] placing them to the [illegible] they discovered that this was a point which, in the general haste and confusion, had not been provided for at all. The general plan in the Civil War had been to assign the men geographically; and it was expected that this plan would still be adhered to. Thus, at one camp, all the men from a certain city ward were assigned to the remount squad. They should have been men with a knowledge of horses. Instead, most of these particular recruits were skilled mechanics. Excellent material for a number of different jobs and especially good for the machine gun corps. But that corps was already made up from a company of husky farmers, not one of whom was capable of assembling a machine gun.

To this situation the professors applied a simple but potent remedy in the "Qualification Card," on which they could record the soldier's trade-skill, his intelligence, his schooling, his wages, and all other important facts about his personal history. Then they secured the help of the ablest employment managers in America to introduce this remedy in the camps. The first of these personnel specialists arrived at Camp Upton. The commanding general received him with interest not unmixed with skepticism.

"Go ahead," he said. "Make your records and let me know tomorrow morning what you have found out."

At seven o'clock the next morning there was placed on the general's desk a complete tabulation of those 2,000 embryo soldiers, showing exactly how many of them had been carpenters, how many blacksmiths, how many barbers, etc. And a couple of hours later the men whose skill was immediately required in getting the camp into shape were hard at work at their special jobs.

Out of the first meeting of the professors of psychology there grew also the "intelligence tests," which have been applied to every man in the army under direction of the Psychology Division of the Surgeon General's office.

It was important for the army to know at once not merely the work a man had done in civil life, but how well he was equipped by nature and training to do it. Was he able to handle men? Did he have quick judgment and resourcefulness? Above all, was his mental and nervous equipment of so low a type that he would be especially susceptible to shell shock? All these questions the intelligence tests were designed to answer. We shall understand them more easily if we watch our friend "Ralph Jones" go through with them, as he did in his first days at camp.

They ushered him, with a hundred other men, into a big empty room and seated them all on wooden benches. Officers, some of them professors of psychology in civil life, passed up and down the aisles, putting a printed folder into each man's hands. A senior officer in front read the general directions.

"To be a good soldier a man must be able to grasp commands quickly and carry them out accurately," said the officer. "These tests are designed to measure your decision, your resourcefulness, and your capacity for forming correct judgment and registering them precisely. There are ten tests, each divided into a number of parts. The first one is comparatively easy, but they increase in difficulty. You will turn to the first test when I order you to do so, and will proceed as rapidly as possible to carry out the ten operations scheduled there, according to instructions. When I call 'Time' you will raise your hands in the air, and hold them there while I explain the second page of tests."

Thus "Ralph Jones" and his hundred associates set forth across a succession of mental hurdles that were to reveal more of their real mental capacity than even their best friends had discovered. For obvious reasons I cannot publish the exact tests used in the army; these are still a military secret. But the specimen tests which are presented here parallel them very closely, and were used before the war in the selection of salesmen by the same group of psychologists who are now at work in Washington.

Taken individually, they seem scarcely more than a succession of mental gymnastics, curious rather than scientific. It is difficult to see how a test consisting of reading rapidly

The Human Rating Scale

I. **PHYSICAL QUALITIES** Physique, bearing, neatness, voice, energy, endurance. Consider how he impresses his command in these respects.	Highest	15
	High	12
	Middle	9
	Low	6
	Lowest	3
II. **INTELLIGENCE** Accuracy, ease in learning, ability to grasp quickly the point of view of commanding officer, to issue clear and intelligent orders, to estimate a new situation, and to arrive at a sensible decision in a crisis.	Highest	15
	High	12
	Middle	9
	Low	6
	Lowest	3
III. **LEADERSHIP** Initiative, force, self-reliance, decisiveness, tact, ability to inspire men and to command their obedience, loyalty and coöperation.	Highest	15
	High	12
	Middle	9
	Low	6
	Lowest	3
IV. **PERSONAL QUALITIES** Industry, dependability, loyalty; readiness to shoulder responsibility for his own acts; freedom from conceit and selfishness; readiness and ability to coöperate.	Highest	15
	High	12
	Middle	9
	Low	6
	Lowest	3
V. **GENERAL VALUE TO THE SERVICE** Professional knowledge, skill and experience; success as administrator and instructor; ability to get results.	Highest	40
	High	32
	Middle	24
	Low	16
	Lowest	8

Rating Scale by Which All Officers of the Army Were Measured.

[illegible] Magazine

Try These Tests on Yourself and Others

north
sour
out
weak
good
after
above
sick
slow
large
rich
dark
front
love
tall
open
summer
new
come
male

5 1 6 8 4 9 2 3 7 0 1 2 7 5 0 4 8 6 9 3 4 1 8 9 0 2 5 6 3 7 1 7 5 6 0 8 9 2 4 3 7 8 6 9 0 4 3 1 2 5
7 8 0 5 1 3 4 2 6 9 2 4 0 9 7 6 1 5 3 8 3 2 0 4 1 5 7 9 6 8 4 8 1 2 6 7 3 9 0 5 3 7 9 0 8 6 5 2 1 4
3 5 9 7 8 4 6 1 0 2 5 1 8 2 3 7 4 9 6 0 8 5 9 3 2 4 1 0 7 6 9 3 4 5 2 0 8 6 1 7 9 3 1 6 7 5 8 4 0 2
2 7 3 9 6 5 0 8 1 4 9 7 3 6 1 5 0 2 8 4 0 4 7 8 5 9 6 2 1 3 0 9 3 1 5 6 4 8 7 2 4 2 3 5 6 7 9 0 8 1
4 2 5 3 0 1 7 9 8 6 3 8 6 0 9 1 5 4 7 2 9 3 6 7 4 8 0 1 2 5 6 4 9 3 1 2 0 7 5 8 6 1 2 7 4 9 0 5 3 8
9 4 7 0 3 8 5 6 2 1 6 0 9 3 8 2 7 1 4 5 7 8 1 0 9 6 4 3 5 2 5 2 7 9 4 1 6 3 8 0 1 0 4 8 2 3 7 9 5 6
0 9 8 2 5 6 1 7 4 3 8 3 5 4 6 9 2 0 1 7 6 0 2 1 3 7 9 5 8 4 2 1 8 4 9 5 7 0 3 6 0 9 5 2 1 8 6 7 4 3
1 0 4 6 2 7 9 5 3 8 0 6 2 8 4 3 9 7 5 1 2 7 4 5 6 0 3 8 9 1 3 5 0 7 8 4 2 1 6 9 5 6 8 1 9 2 4 3 7 0
8 6 1 4 9 2 3 0 5 7 4 5 1 7 2 8 6 3 0 9 1 9 5 6 8 3 2 7 4 0 8 6 2 0 7 3 5 4 9 1 2 4 7 3 5 0 1 8 6 9
6 3 2 1 7 0 8 4 9 5 7 9 4 1 5 0 3 8 2 6 5 6 3 2 7 1 8 4 0 9 7 0 6 8 3 9 1 5 2 4 8 5 0 4 3 1 2 6 9 7

WITH your pencil cross out every 3. There are five in each line. The score is the time required, in seconds. Average adult record is 76 seconds. Under 64 seconds is Excellent, 64 to 76 seconds is Good, 76 to 88 seconds is Fair, over 88 seconds is Poor

LOOK at each word in the test on the left, see what it means, and call out the word that means just the *Opposite* to each word. The score is the time in seconds, with no errors. The average adult record is 25 seconds. Below 21 seconds is Excellent, 21 to 25 seconds is Good, 25 to 29 seconds is Fair, over 29 seconds is Poor.

8-3
6-4-1
2-8-5-4
3-1-7-5-9
5-2-1-7-4-6
2-1-8-3-4-3-9
7-2-5-3-4-8-9-6
9-5-4-2-3-7-1-8-6

HAVE someone read the numbers on the left to you, at the rate of one digit a second. When they have finished a line repeat the numbers in the same order as read. This is a test of immediate memory. The average adult can remember 7 numbers. More than 8 is Excellent, 7 to 8 is Good, 6 to 7 is Fair, below 6 is poor.

With your pencil make a dot over any one of these letters F G H I J, and a comma after the longest of these three words: boy mother girl Then, if Christmas comes in March, make a cross right here ....but if not, pass along to the next question, and tell where the sun rises....... .... If you believe that Edison discovered America, cross out what you just wrote, but if it was some one else, put in a number to complete this sentence: "A horse has .... feet." Write *yes*, no matter whether China is in Africa or not ....; and then give a wrong answer to this question: "How many days are there in the week?".......... Write any letter except *g* just after this comma, and then write *no* if 2 times 5 are 10........ Now, if Tuesday comes after Monday, make two crosses here........; but if not, make a circle here........ or else a square here..... Be sure to make three crosses between these two names of boys: George..........Henry. Notice these two numbers: 3, 5, If iron is heavier than water, write the larger number here......., but if iron is lighter write the smaller number here........ Show by a cross when the nights are longer; in summer?........ in winter?........ Give the correct answer to this question: "Does water run uphill?".......... and repeat your answer here........ Do nothing here (5+7= ....), unless you skipped the preceding question; but write the first letter of your first name and the last letter of your last name at the end of this line:

THE test above takes the average adult 125 seconds. Fifty per cent of average educated adults come somewhere between 100 seconds and 150 seconds. To take less than 100 seconds is to be in the superior 25 per cent. To take more than 150 seconds is to be in the poorest 25 per cent. If people are divided into Excellent, Good, Fair and Poor, Excellent will be anything less than 100 seconds; 100 to 125 will be Good; 125 to 150 will be Fair, while over 150 will be Poor.

On each line of dots write the word which makes the best meaning

ONLY ONE WORD ON EACH BLANK

1 The sky........ blue.
2 We are going ....school.
3 The kind lady .... the poor man a dollar.
4 The .... plays ....her dolls all day.
5 Time .... often more valuable .... money.
6 Boys and .... soon become .... and women.
7 The poor baby .... as if it were .... sick.
8 The .... rises .... the morning and .... at night.
9 It is good to hear .... voice .... friend.
10 She .... if she will.
11 The poor little .... has .... nothing to ....; he is hungry.
12 The boy who .... hard .... do well.
13 Men .... more .... to do heavy work .... women.
14 It is a .... task to be kind to every beggar .... for money.
15 Worry .... never improved a situation but has ....made conditions ....
16 A home is .... merely a place .... one .... [illegible] comfortably.
17 It is very .... to become .... acquainted .... persons who .... timid.
18 To .... many things .... ever finishing any of them .... a .... habit.
19 One's real .... appears .... often in his [illegible] in his speech.
20 When one feels drowsy and ...., it .... happens that he is .... to fix his attention very successfully .... anything.
21 The knowledge of .... use fire is .... of .... important things known by .... but unknown .... animals.
22 .... that are .... to one by an .... friend should be pardoned .... readily than injuries done by one .... is not angry.
23 To [illegible] friends is always [illegible] the [illegible]
24 One ought to .... great care to .... the right [illegible] of habits, for one who .... bad habits .... it [illegible] to get away from them.

THIS test is not a speed test but one of quality. Half an hour is allowed. The average 8-year-old can just do the first two; the average 9-year-old the first four; the average 10-year-old the first six; etc., up to the average college freshman, who can just do the whole test. This is known as Trabue's Compl[illegible]

[illegible] separate the intelli- [illegible] A paragraph like [illegible] the creation [illegible] one of these [illegible] longest of these [illegible] If Christmas comes [illegible] but if not, pass along to the next question and tell where the sun rises . . ..” etc.

Just what relation has such apparent nonsense to the [illegible] business man. [illegible] important elements [illegible] to grasp facts and [illegible] and reach a sure [illegible]. The intelligence tests call for the exercise of every [illegible] some of them are constructed so as to give a pretty good measure of a man's range [illegible]

[illegible] theoretical for a [illegible] method of judging [illegible] in the same line of business, whose incomes vary widely, and give the same test to all of them. If, generally speaking, it rates them in about the same order in which the judgment of the business world has rated them, then the test is pretty likely to be a [illegible] then it probably will have to be tinkered with until it gives results which correspond to the known abilities and records of the men on whom it was tried. When it has been proved in this way, it [illegible] records and abilities are not known.

The army tests have been a good deal revised since their introduction, as experience showed them susceptible of improvement; but from the very beginning they produced results which are amazing. Two men arrived on the same day [illegible] They were about the same age, each gave his occupation as “printer,” and both claimed about the same number of years' experience. They were perfect material for the intelligence tests. In the spirit of good-natured skepticism they were sent to the captain in charge of the Psychology Squad. “Here,” said the skeptics, “are two men of the same age, trade, and experience. See [illegible]” The two went through the tests and, when their papers were marked, behold! One of them was ranked well up in the B class and the other far [illegible]

“Ha, ha!” said the skeptics. “We told you so.”

But the psychologist was not disturbed. He questioned the two men, and after a bit the truth came out. Both of them were printers, to be sure; but the man whom the tests had ranked high had been the foreman of a printing establishment; and the other had never risen higher than the operation of a power trimmer. The relative ability which they had shown in their years of practical experience had been demonstrated by the tests in a brief half-hour.

On a scale of 414 points the officers in the army averaged 310 and enlisted men about a hundred and fifty points below. Of 7,550 drafted men who were tested at Camp Wadsworth within a given period, those who had been civil engineers ranked highest, with an average score of 290; from that point the occupations ranged downward until at the bottom of the list came barbers, with an average score of only 83, and laborers, with an average of 80.

There was considerable doubt in the minds of West Pointers, when the psychologists made their appearance in the camps. But it was soon discovered that the tests indicated with unexpected precision what men had the qualities which would make them good non-commissioned officers; and, also, what men were worth watching as material for the commissioned officers' training camps.

“Ralph Jones” stood well in the intelligence tests; he showed in his daily work qualities which commended themselves to his superiors. In course of time he was sent to an officers' training camp and graduated as a first lieutenant. The questions then arose, Is he a likely candidate for promotion? What sort of captain would he make? And that question his superiors answered, not by guess, nor “hunch,” nor by prejudice, but by the critical analysis of the rating scale. An exceedingly ingenious device that rating scale—a human yardstick—for matching a man by testing his physical qualities against those of his immediate superiors; his intelligence against theirs; his leadership against theirs.

With the scale before him, “Ralph's” captain made a list of all the captains with whom he was acquainted. Then, on the top line (see the scale reproduced on page 7), opposite the words “Physical Qualities,” he wrote the name of the one man who, in his judgment, stood above all the rest in the way he impressed his men by his physique, bearing, neatness, voice, energy and endurance. On the bottom line he wrote the name of the captain who, in his opinion, ranked lowest in these qualities. On the third line he wrote the name of a third man, half way between these two; and on the second and fourth lines the names of captains who would stand in these positions respectively in relation to the others. Opposite the words “Intelligence,” “Leadership,” “Personal Qualities,” and “General Value to the Service,” he made similar lists of captains. Then with his marked scale before him he sought conscientiously to place “Ralph” in his proper place opposite each quality—matching him in each case against the actual men whose names were written there. In physical qualities he judged that “Ralph” was nearest like the middle captain, and so in that characteristic he gave him nine points. In intelligence he ranked him as the equal of the second captain on the list, and “Ralph” scored twelve under that heading. And so on to the bottom of the list. Adding up “Ralph's” score, he found that it amounted to sixty-seven; and that figure he reported to Washington, where it was written opposite “Ralph's” name.

Until one has seen the rating scale in actual use it is difficult to believe how exact are the results obtained by it. In dozens of instances two or more colonels have rated the same major independently, and have not varied in their ratings half a dozen points. Two majors landing from France undertook to rate a certain captain; and, comparing their ratings later, discovered that both of them had rated him at seventy-four. Judged objectively and alone, the human being is difficult to place; we speak of him vaguely as “a good fellow,” or “only fair,” or “a first-class man.” But measured by the yardstick of other human beings it is possible to speak in terms far more concrete. He is a better man than Brown in physical appearance and not so good a man as Black. Therefore, if Brown be six on the rating scale, and Black is twelve, Jones' position is fixed exactly. His number is nine, and there is no getting away from it.

This, then, was the third contribution of Psychology to the organization of the army—the Rating Scale, which made it possible to classify every officer in the army, not by theory or by prejudice, but by the measure of his capacities against those of other officers of the rank above—the rank he would have if promoted.

It requires no prophet to foresee the wide application of these new factors to the problem of business. Long before the war the intelligence tests and the rating scale were already being used by a dozen of the largest and most progressive concerns in selecting salesmen, having been developed for this purpose by the same group of professors who have so greatly extended their application in the army. Those concerns had discovered that they were able very greatly to reduce their “labor turn-over” because the tests helped them to weed out at the beginning a good half of the men who would have failed. Moreover, by means of the rating scale their sales managers were given a definite, living basis of measurement, as against the “general impression” of the applicant, which had been their main guide before.

I know of a concern which employs a thousand salesmen on commission; and to keep the ranks of that thousand full it hires from five to seven thousand men a year. What a tale of tragic blundering! To place samples in the hands of a new man and to put him onto the street in search of orders costs that concern not less than fifty dollars. Three hundred thousand dollars a year it loses, because only one man out of six or seven is fitted for the work, and the concern has had no method of picking the one out of the six except by starting them all out and letting five fail.

Think, too, of the destruction of self-respect, the loss of confidence, the hours of heartache and mental torture which are the lot of the five unsuccessful men! It will be harder for them to succeed in another place; they will take up their next task with less of hope and confidence, because they tried a job for which they were not fitted and, after the trying, failed.

A good deal of the pathos of the square peg in the round hole will be removed after the war, when these methods come to be generally employed. The future sales manager of the company which I have just mentioned, and other men who hire employes, will have their individual intelligence tests, designed for them by consulting psychologists to meet their special requirements.

It will mean three great things when these scientific methods of determining the fitness of men come into general use. First of all, men will be better placed. There will be fewer rolling stones who travel from one job to another, losing in each futile move a trifle of courage and of self-respect. Second, it will save millions in "labor turn-over" at a critical time in our business history. And, finally, as the psychologists progress, and the tests are worked out in more detail and made generally available, it ought to be possible for a man to measure himself—to know himself far more exactly than the average man ever succeeds in doing. By the help of science, he will be able to determine something of his own qualifications and direct his course toward the thing which of all things in life is most desirable—a job he can master and enjoy.

The little group of psychologists in Washington, who are at present camouflaged as colonels and majors and captains, are very insistent that neither the intelligence tests nor the rating scale can be infallible, either now or in the future. No tests will ever be devised that can take the place of a careful examination of a man's records, or the shrewd application of hard common sense. But the results of this new development speak for themselves. They have helped to build for us in twenty months an organization that gave the finishing blow to a rival organization which had been forty years in building. And three million men who, in the beginning, looked upon the presence of the psychologists in the camps as an amusing and harmless interlopement, have learned a new respect for science in its application to hard, practical affairs. We might as well begin right now to reckon with that respect in our conceptions of the future of Business in America. For "Ralph" and his three million associates are coming back to be our governors, our general managers, and our sales managers—to organize business and to put themselves and the rest of us in the places in industry where we best belong.

Concrete for Tunnel Sewer Placed Through Post Holes Bored in Roadway

A novel method of concreting was employed last year in constructing the Glen Road section of the Moore Park drainage scheme at Toronto, Ont. The concrete sewer is laid in tunnel under a covering of 25 ft. or less. The total length is 2,812½ ft. The sewer is 4 ft. in height at the crown and 4 ft. 3 in. in horizontal diameter at the invert, with the profile of the crown walls embodying arcs of three different radii. The minimum wall thickness is 9 in. The method of concreting is described as follows in The Contract Record: Owing to the lack of space in the tunnel, it was decided not to pour in the conventional way from the tunnel by erecting forms little by little and placing the concrete simultaneously. The crown section would have caused difficulty and extra labor would have been involved in transporting concrete from the shaft to the heading. The contractors in view of this condition, bored post holes through the roadway directly to the sewer tunnel, each hole being in the center of an 8-ft. section. The forms were erected completely, the open end bulkheaded and the concrete mixed at the surface of the road and poured through the post holes. With a rather soft mixture this scheme worked admirably and the pressure behind the concrete was sufficient to eliminate all voids. When the pouring was complete the post holes were filled with concrete and resurfaced with asphalt. The crown walls were poured before the invert, this being afterwards concreted and keyed to the sides. A portable Foot gasoline batch mixer was used for the manufacture of concrete. The mixture was 1-2-3, with 1 in. crushed stone. The entire job was carried out in winter weather. This necessitated the heating of the supplies by means of steam coils. Owing to the impossibility of obtaining sand and stone by rail from outside pits, the contractors had to haul these materials by sleigh from pits.

Cost of Sewer Maintenance at Newton, Mass.—During 1918 the city engineer's department of Newton, Mass., cleaned and repaired 129.78 miles of sewer, the average cost per mile amounting to $75.25. The cost of flushing sewers was $21.20 per mile.

A Vocabulary Test of Intelligence

In his book, "The Measurement of Intelligence," Prof. Lewis M. Terman of Stanford University, proposes a vocabulary test of intelligence, that he claims will give results within 10 per cent of those obtained by the Binet-Simon psychological tests. The test consists in defining 100 words, selected according to some arbitrary rule, the idea being that the number of definitions given by an individual will furnish an index to his vocabulary. The 100 test words used in Prof. Terman's book were derived by taking the last word of every sixth column in a dictionary containing 18,000 words. These words were as follows:

1. orange
2. bonfire
3. roar
4. gown
5. tap
6. scorch
7. puddle
8. envelope
9. straw
10. rule
11. haste
12. afloat
13. eye-lash
14. copper
15. health
16. curse
17. guitar
18. mellow
19. pork
20. impolite
21. plumbing
22. outward
23. lecture
24. dungeon
25. southern
26. noticeable
27. muzzle
28. quake
29. civil
30. treasury
31. reception
32. ramble
33. skill
34. misuse
35. insure
36. stave
37. regard
38. nerve
39. crunch
40. juggler
41. majesty
42. brunette
43. snip
44. apish
45. sportive
46. hysterics
47. Mars
48. repose
49. shrewd
50. forfeit
51. peculiarity
52. coinage
53. mosaic
54. bewail
55. disproportionate
56. dilapidated
57. charter
58. conscientious
59. avarice
60. artless
61. priceless
62. swaddle
63. tolerate
64. gelatinous
65. depredation
66. promortory
67. frustrate
68. milksop
69. philanthropy
70. irony
71. lotus
72. drabble
73. harpy
74. embody
75. infuse
76. flaunt
77. declivity
78. fen
79. ochre
80. exaltation
81. incrustation
82. laity
83. selectman
84. sapient
85. retroactive
86. achromatic
87. ambergris
88. casuistry
89. paleology
90. perfunctory
91. precipitancy
92. theosophy
93. piscatorial
94. sudorific
95. parterre
96. homunculus
97. cameo
98. shagreen
99. limpet
100. complot

The following interesting discussion of this vocabulary test is taken from the Journal of Heredity:

It may seem to the reader almost incredible that so small a sampling of words would give a reliable index of an individual's vocabulary. That it does so is due to the operation of the ordinary laws of chance. It is analogous to predicting the results of an election when only a small proportion of the ballots have been counted. If it is known that a ballot-box contains 600 votes, and if when only 30 have been counted it is found that they are divided between two candidates in the proportion of 20 to 10, it is safe to predict that a complete count will give the two candidates approximately 400 and 200 respectively. In 1914 about 1,000,000 votes were cast for governor in California, and when only 10,000 votes had been counted, or a hundredth of all, it was announced and conceded that Governor Johnson had been re-elected by about 150,000 plurality. The completed count gave him 188,505 plurality. The error was less than 10 per cent of the total vote.

The 100 words thus chosen are arranged approximately in the order of their difficulty, and the examiner usually begins with the easier words and proceeds to the harder, continuing until the subject examined is no longer able to define the words.

"With children under nine or ten years," Dr. Terman directs, "begin with the first. Apparently normal children of ten years may safely be credited with the first ten words without being asked to define them. Apparently normal children of twelve may begin with word 16 and 15-year-olds with word 21. Except with subjects of almost adult intelligence, there is no need to give the last ten or fifteen words, as these are almost never correctly defined by school-children. A safe rule to follow is to continue until eight or ten successive words have been missed and to score the remainder minus without giving them."

As to scoring, credit a response in full if it gives one correct meaning for a word, regardless of whether that meaning is the most common one, and regardless of whether it is the original or a derived meaning. Occasionally half credit may be given, but this should be avoided as far as possible.

To find the entire vocabulary (of the individual who is being examined), multiply the number of words known by 180. Thus the child who defines twenty words correctly has a vocabulary of 20 × 180 = 3,600 words; fifty correct definitions would mean a vocabulary of 9,000 words, etc. The following are the standards for different years, as determined by the vocabulary reached by 60 per cent to 65 per cent of the subjects of the various mental levels:

	Words.	Vocabulary.
Eight years	20	3,600
Ten years	30	5,400
Twelve years ...	40	7,200
Fourteen years	50	9,000

[illegible]

[illegible] it is not [illegible] The [illegible] is intended to [illegible] rather than the evolution of [illegible] that the child has one [illegible] is given full credit for it, however poorly the definition may have been stated.

[illegible] now and then in [illegible] this happens [illegible] expect. In order to get a definite idea of the extent of error due to the individual [illegible] had the definitions of twenty-five subjects graded independently by ten different persons. The results showed an average difference below three in the number of definitions scored plus. Since these subjects attempted on an average about sixty words, the average number of doubtful definitions per subject was below 5 per cent of the number attempted.

An idea of the degree of leniency to be exercised may be had from the following examples of definitions, which are mostly low grade, but acceptable:

1. [illegible] "It is yellow and grows [illegible]"

2. [illegible] "You burn some leaves or things." "It's a big fire."

3. Roar. "A lion roars." "You holler loud."

4. Gown. "To sleep in." "It's a nightie." "It's a nice gown that ladies wear."

The test is particularly interesting, since it seems to give reasonably correct measurement of the intelligence of adults, and there are very few single tests which can be easily applied that give reliable results in such cases. There is, Professor Terman finds, a well-marked difference between the average adult and the superior adult, although the number of words in the vocabulary by which they differ is only ten. A majority of average adults can give 65 words, but only one-third of them can give 75 words—the test of the superior adult. But of those whom extensive testing shows to be "superior adults," 90 per cent can pass the superior adult test of 75 definitions. Ability to pass the test is relatively independent of the number of years the subject has attended school, our business men showing even a higher percentage of passes than high school pupils.

While this test may be more reliable than any other single test, it would be a mistake to place too much dependence on it. It is somewhat influenced by the kind of training and education one has had—although less so than would be expected. No single test, and no series of tests, is an adequate measure of the general intelligence. The trained examiner takes account of every clue he can find, and it would be a disservice to psychology to give the impression that any tests are infallible, especially if given by unskilled examiners or by autoexamination. The most that is claimed for the Binet tests, for example, may be stated in Dr. Terman's own words:

"One who knows how to apply the tests correctly and who is experienced in the psychological interpretation of responses can in forty minutes arrive at a more accurate judgment as to a subject's intelligence than would be possible without the tests after months or even years of close observation. . . . Exceptionally superior endowment is discoverable by the tests, however unfavorable the home from which it comes, and inferior endowment can not be normalized by all the advantages of the most cultured home. Or, to quote from William Stern, the greatest German exponent of the psychology of individual differences, 'The tests actually reach and discover the general developmental conditions of intelligence, and not mere fragments of knowledge and attainments acquired by chance.'"

Cost of Sewerage at Newton, Mass., $56 Per Capita.—The total cost to the end of 1918 of the sanitary sewer system of Newton, Mass., was $2,310,000, according to the last annual report of E. H. Rogers, City Engineer. Of this total $2,303,300 is for the mains and $6,700 for a pumping station. The total assessments that have been levied for the construction amounted to $874,498, the proportion of the cost of the system assessed on abutters, thus being 37.2 per cent. The assessment is based on a rate of 20 ct. per lineal foot of frontage, and 1 ct. per square foot of area drainable within 125 ft. of street. The population of the city in the 1915 census was [illegible].

Methods of Drilling and Test Results of Large Capacity Well

The water supply of the University of Illinois is obtained from six wells in the glacial drift. Five of them, ranging in depth from 138 to 142 ft. and with capacities of 60 to 81 gal. per minute, were put down some years ago. The sixth well was accepted last December. Interesting information regarding the new well was given by Mr. M. L. Enger, Professor of Mechanics and Hydraulics, University of Illinois, in a paper presented March 25 at the annual meeting of the Illinois Section of the American Waterworks Association. An abstract of the paper follows:

In October, 1915, the University entered into a contract with the Layne & Bowler Co. of Memphis, Tenn., for a well and motor-driven pump. The payment agreed upon was $19 per gallon per minute after one year's operation. It was stipulated that the minimum overall efficiency of the motor and pump was to be 55 percent.

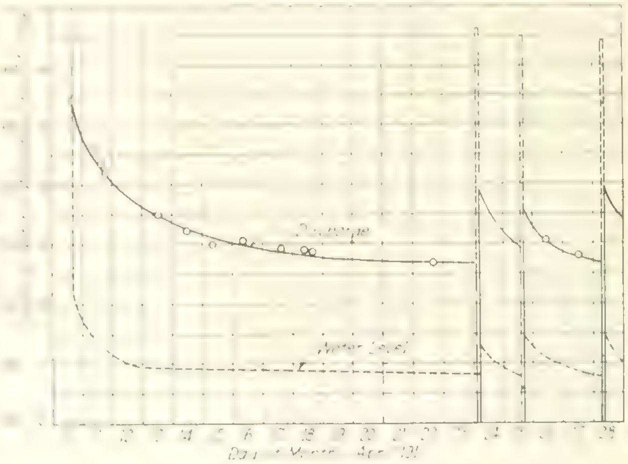


Fig. 1—Results of Test of Well No. 6.

The well was drilled by the rotary process, beginning Jan. 17, 1916, and finishing May 5, 1916. The well is 36 ins. in diameter to a depth of 160 ft. and 30 ins. in diameter for the next 9 ft. The driller furnished the following log:

	Total depth. Ft.
50 ft. of clay and gravel mixed	50
15 ft. of clay and rock	65
30 ft. of hard clay and sand mixed	95
47 ft. of hard sand and gravel......	142
26 ft. of very hard and fine sand....	168
5 ft. of hard sand and a little clay.	173

The well was completed by putting in 98 ft. of 24-in., No. 8 gauge casing; 70 ft. of 24-in. No. 6 Layne patent shutter screen, No. 8 gauge; and 4 ft. of shutter seal, 16-in. by 22-in. with a 6-in. cypress bottom. The space between the screen and casing and the wall of the well was filled with 1-in. gravel.

A turbine pump was placed in the well, and was started and stopped frequently in order to break down and wash away the mud wall which had been left by the drilling process, and also to carry away the finer particles of sand in the waterbearing stratum near the well. It was hoped in this way to form a cavity under the heavy clay roof, indicated in the above log, into which the gravel would flow and thus increase the capacity of the well. The driller states that about 30 cu. yd. of gravel were fed in at the top.

A preliminary test showed a yield of more than 1,000 gal. per minute with a draw down of 53 ft., or a specific capacity of more than 19 gal. per minute per foot of draw down. The well now has a specific capacity of 21.5 gal. per minute. Data concerning Well No. 4 at the University will be of interest in making comparisons. This well was tested immediately after its construction in 1906 and showed a yield of 108 gal. per minute with a draw down of 15 ft., or a specific capacity of 7.2 gal. per minute. In 1916 the yield of this well was 71 gal. per minute with a draw down of 14.6 ft., or a specific capacity of 4.9 gal. per minute. That is to say, Well No. 4 in 10 years of operation has had its specific capacity reduced more than 30 percent, while the new well in about 2 years of normal use has had its specific capacity increased by about 10 percent.

It was soon found that a yield of 1,000 gal. per minute could not be maintained for any length of time without having the water level in the well and in the older wells gradually lower. A test was begun April 11, 1917, in which it was intended to run the pump continuously until the water level in the well should become constant. The water level went down quite rapidly during the first two days of the test and it continued to go down slowly until the morning of April 25, when some trouble at the switchboard caused the circuit breaker to blow out, stopping the pump. It was started again about 20 minutes later, but during the interval the hydraulic constants of the well had been changed greatly. Before the pump was stopped the discharge had been about 670 gal. per minute for several days. When the pump was started again the discharge was about 790 gal. per minute and 24 hours later it was about 710 gal. per minute. The curves in Fig. 1 show the water level in the well and the discharge during the test. The change in the hydraulic constants was probably due to fine sand drifting toward the well becoming entangled, gradually choking up the water-bearing stratum near the well. When the pump was stopped, the flow toward the well ceased, allowing some readjustment in the positions of the sand grains. When the pump was again put into operation some of the sand was washed into the well leaving the water passages near the well less restricted.

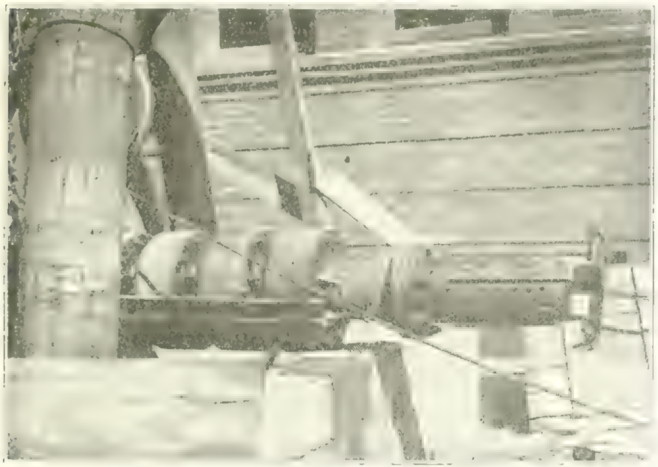


Fig. 2—New Pump Installation.

The temporary installation was replaced by a 6-stage, No. 4, 15-in. Type CLC Layne pump driven by a 50-HP. Westinghouse 2-phase induction motor through a flexible coupling. Views of the pump are shown in Fig. 2.

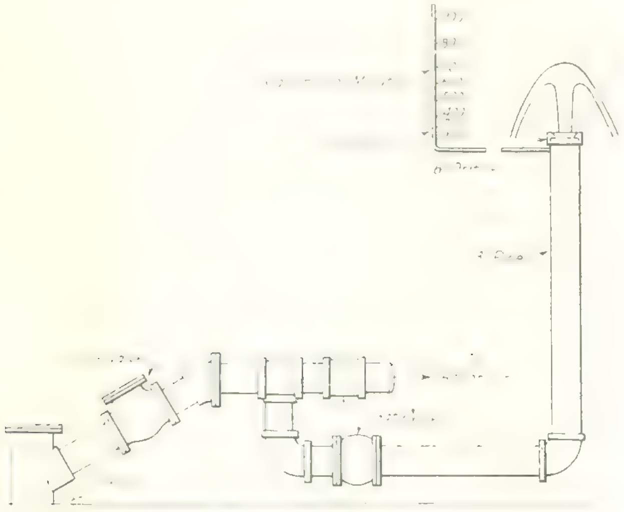


Fig. 3.—Arrangement of Vertical Jet Measuring Device.

The pump is located in a pit 12x12 ft., 11 ft. deep, with concrete bottom, sides and roof. The pit is drained into a tunnel which carries the steam heating pipes into an adjacent building. Before the concrete floor was put in, the gravel between the casing and the wall of the well was replaced with clay to a depth of 6 ft. below the floor of the pit. There seems to be no chance for contamination to get into the well. Frequent tests of the water have shown it to be of excellent sanitary quality.

In order to obtain continuous records of the water level in the well, a recording gage is used to record the pressure required to keep a small quantity of air bubbling from the end of a 1½ in. pipe which hangs in the well and extends below water level at all times. The pressure in the air pipe is equal to the head of water above the end of the pipe, hence the gage shows the submergence of the end of the air pipe at all times. The records show when the pump is started and stopped and are found very useful in the preparation of operation statistics.

In order that the discharge may be measured at any time, a vertical jet apparatus has been installed in a manhole just outside of the concrete pit. The manhole is drained by a 12-in. vitrified pipe discharging into a storm sewer. The vertical jet apparatus was calibrated in the hydraulics laboratory of the University by setting up the entire pipe line from the valve to the orifice. The equation of the orifice was found to be $Q = 530\sqrt{h}$ gallons per minute, h being the head in feet measured by a piezometer connected to the pipe 3 ins. below the orifice. The pipe is 8 ins. and the orifice is a 6 in. circular hole drilled in an 8-in. cap screwed to the end of the pipe. The general arrangement is shown in Fig. 3.

An acceptance test was made Dec. 28, 1918, showing an average overall efficiency of 55.6 percent when delivering 587 gal. per minute against a head of 136.9 feet, and an efficiency of 59.3 percent when delivering 536 gal. per minute against a head of 156.4 ft.

Compared with the other well equipment the new one has the disadvantage of a 15-ft. greater draw down. But since it has never been possible to maintain the average efficiency of the reciprocating well pumps as high as 50 percent, the turbine pump will get the water out of the ground with a smaller power consumption than the reciprocating pumps. In the cost of maintenance the new unit seems to have a considerable advantage over the older ones. With the older equipment the cost of maintenance has amounted to about 0.8 of a cent per 1,000 gal. The new equipment has not been in use long enough to draw definite conclusions, but the indications are that the maintenance cost will be comparatively small.

Waterworks Operations at Virginia, Minn., in 1918

The total pumpage at the municipal water plant of Virginia, Minn., for the year ending Oct. 1, 1918, was 289,446,300 gal., which is approximately the same amount as in the previous year, but about 16,000 gal. less than for 1916. This reduction, states the last annual report of C. T. Harding, Superintendent, was undoubtedly due to the installation of meters. The amount of water would have been larger except that much water was used for war gardens last year. This was encouraged by making a special sprinkling rate which many took advantage of. Estimating that there are 16,000 people on the water service, this annual consumption of 289,446,000 gal. shows that they are now using 49 gal. per capita per day. While this consumption, states the report, is too large for a city like Virginia, it compares very favorably with a consumption of 61 gal. per capita per day which prevailed before meters were installed. The rates have not changed within the last year and are now as given in the following schedule:

First	[illegible]
Next	[illegible]
[illegible]	[illegible]

By far the largest part of all the water consumers are now on meters. All large consumers are metered and only in a very few cases are there any flat rates still in use. It is intended ultimately to put meters on all of these consumers. The Department has discontinued the practice of installing 4-in. hydrants and is now installing 6-in. hydrants as these give much better pressure when large amounts of water are being used in times of fire. The income of the department from water sales amounted to $35,946; for hydrant rental $10,633 was received.

The Lime Softening of Water and the Use of Sludge as an Aid*

By W. A. SPERRY

[illegible] Grand Rapids, Mich.

[illegible] built in two [illegible] in series. The [illegible] period of 2[illegible] minutes [illegible] part provides for [illegible] million gallon rate. [illegible] to provide for four [illegible] ft. long, the larger [illegible] 44 ft. long, the baffles being in each case of the "round the end" or horizontal type. The larger chamber is further so arranged that the water may be drawn off from it to the settling basins at either of the quarter way intervals.

[illegible] at Grand Rapids with the changing seasons and illustrates the relations of time and temperature.

With the river water running 220 parts per million total alkalinity and a magnesium content of 20 parts per million the temperature of the water ranging around 32 to 45° F. the following alkalinity results from various parts of the mixing chamber result:

	[illegible]	[illegible]	[illegible]	N. carb.	Mg.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	15.1
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	15.1
Alum applied here at the rate of 1.5 grains per gallon.					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11.8
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Here the significant thing is that under summer conditions [illegible] ranging up around 70 to 80° F. the results attained after 70 minutes as shown above would be attained at the 23 to 29 minute point with the alum dosage ranging 1 grain per gallon less and with greater rates [illegible].

The essential feature of chemical application that seems to have crystallized into definite practice for lime softening at Grand Rapids is that the lime should be added at the earliest possible moment to the water under treatment:

(a) To insure as far as possible complete precipitation of calcium as carbonate.

(b) To maintain sufficient caustic alkalinity or excess of lime as that there may be 5 to 10 parts per million remaining in the water at the point of discharge into the settling basins that the magnesium may be carried through the more soluble carbonate state to the less soluble, colloidal hydrate state.

(c) To delay the application of the coagulant as late as possible to the mixing chamber to still be assured of its thorough mixing with the water before discharge to the settling basins, the alum playing a part not so much chemically to reduce alkalinity as physically to scour out and precipitate colloidal matter.

The application of this water to the filters and city mains has resulted, through a somewhat insufficient period for "curing" or "maturing" in the settling basins, in a very moderate amount of after reaction trouble which has:

(A) Much incrusted the filter sands, though the extent to which this has occurred lessens by that much trouble in the distribution system.

(B) Lined up about 10-11 percent of the 22,000 meters in service per year, Grand Rapids being some 97.8 percent metered.

(C) Coated the service mains to a thickness of 1-16th to 1-32d inches in the last 6 years, and causing some trouble thereby in the opening of valves and gates.

(D). Given some more or less persistent trouble with hot water heating apparatus, gas heaters, furnace coils and the like.

Tables I and II give in some detail the comparative condition of the sand and the history of the meters for the year 1917-18.

This represents 17 percent of the total number of meters in use 66 percent of which were lime coated enough to cause their shopping, an item of considerable expense.

During the winter of 1912-13,. the first year of operation, there was a rather intensified period of trouble with the hot water heating systems. Steam coil heated tanks would become "furred" 3 to 4 in. thick in a week's time. Instantaneous gas heater coils would become completely choked up, as would the furnace coils, later, burning out. We are convinced, however, that much of this trouble could have been avoided by better design in the way of more ample pipe sizes, and in the simplifying of design by the elimination of many unnecessary ells, and other reductions all of which seemed favored places of deposit for the lime coatings.

This trouble being the more aggravating in that it occurred at such a time as to make concurrent the most difficult water to treat with the greatest demands for hot water heating.

Laboratory tests seemed to identify this with the percent of magnesium removed such that when the removal effected was 25 percent or more the trouble from this source was reduced materially. Operation in the succeeding years, therefore, became controlled by the percent of magnesium removed, in that with magnesium removed to the extent of 33 to 46 percent troubles due to after deposits were apparently diminished and complaints arising from trouble with hot water heating apparatus decreasing.

Within the last year continued efforts to cope with the small but persistent troubles arising from after deposits coupled with reasons of an economic nature arising out of the increasing costs for alum have led us to change somewhat our ideas as to the exact role played by the magnesium in lessening such troubles, in that whereas formerly, we believed our troubles due almost entirely to colloidal magnesium and bent all efforts towards its removal, through increases of the amount of alum used and the rigid maintenance of residual caustic alkalinity, the fact that magnesium was not a predominating characteristic in the coatings deposited, there being but 8 to 15 percent therein, did not seem to "square" with our theory even though it was a pronounced fact removal of magnesium was consistent with reduced after reaction troubles.

We are beginning to suspect that in reality the major cause of our more stable effluent lay in the fact of a reduced normal carbonate content of the water going to the city mains. That while it was true that increase of alum and maintenance of caustic alkalinity increased the amount of magnesium removed proportionately it also not only reduced the normal carbonate content of the water but in addition maintenance of caustic alkalinity tended to prevent deposit to some extent of that portion of normal carbonate that may have been present in a supersaturated state.

Table III is interesting as throwing some light on this fact. In 1912-13 occurred our worst period of after deposit troubles, that for that year our magnesium removal was but 25 percent and that the normal carbonate alkalinity of the city water for that period was greater than for the average of the succeeding years by 51 percent being 65 parts per million as against an average of 43 for the 5 succeeding years.

There was a constant seeking for some method of operation that would compensate for our rather insufficient settling basins for lime softening operations such that would

TABLE I. [illegible] SAND [illegible] AND 1918

	Sand [illegible]	Sand as found Aug. 1918
[illegible]	[illegible]	Above 1.65 mm
[illegible]	[illegible]	1 [illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible] M.M
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

TABLE II. [illegible] WITH THE [illegible] JUNE 1 AND [illegible]

	Percent	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	216
[illegible]	[illegible]	728
Lime and mechanical trouble	12.1	461
[illegible]	[illegible]	2[illegible]2
	100	3.827

TABLE III.

Year.	Normal [illegible]	C. alk. water, [illegible] mains	Per cent mag. removed	Grains alum applied
1913	[illegible]	1	25.0	1.6
1914	44	5	33.6	0.7
1915	[illegible]	[illegible]	37.6	0.9
1916	[illegible]	[illegible]	[illegible]	1.2
1917	[illegible]	[illegible]	[illegible]	1.7
1918*	[illegible]	[illegible]	[illegible]	1.2

*To Aug. 1.

Results stated in parts per million and representing the yearly average.

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*[illegible] eleventh annual [illegible] Waterworks Association.

save to ourselves all the desirable and economic features of a soft water without a continuance of the various troubles discussed and without the expenditure of increasing amounts of alum the cost of which was mounting.

The experiments were largely inspired by what was being done with the use of air and sludge in the treatment of sewage and the possible feasibility of pumping back in like manner the settling basin sludges into the mixing chamber to intensify the removal of colloids, to save alum if possible, and at the same time to so accelerate the "curing" of the water as to stabilize the effluent to a point of possibly eliminating entirely the after reaction troubles and its attendant annoyance to the hot water user, the expense of cleaning limed meters, and the elimination of sticking gates and valves.

The sludge in question is a mixture of some 85 percent calcium carbonate, 4 percent magnesium hydrate, aluminium hydrate, mud, organic matter, etc., and is produced in enormous amounts. It collects to the extent of covering our settling basins, which are approximately 110 ft. by 210 ft. by 12 to 15 ft. deep, with a layer of sludge from 1 to 10 ft. deep with ⅓ to ½ the area covered to a depth of 8 to 10 ft. deep every 1 and ½ to 2 months and aggregates 6,000 to 7,000 tons a year based upon an average pumpage of 12.2 million gallon per day and a reduction of the raw water in total hardness through the use of lime of from 225 parts per million to 95 parts per million for the water passing to the city mains as the average for 6 years, a reduction of 60 percent.

Preliminary laboratory experiments indicated:

(A) That time of contact was not a factor beyond the time required for thorough inter mixing.

(B) That the volume of sludge in contact was of exceeding importance.

(C) That the sludge was most effective when applied to water from the mixing chamber taken at a point just after the alum addition, i. e. at a point where the normal lime reactions were most nearly completed.

(D) It seemed most effective therefore, not so much to hasten the chemical reactions as to remove the products of the reaction.

(E) That the sludge did not seem so effective at least in the volumes attainable by the pumps at hand when applied to water treated under summer conditions as when applied to water treated under winter conditions.

Table IV is typical of some of the laboratory results and illustrative of points A and B above.

In each case the amount of air applied was such as to just keep the sludge well up in suspension the results of which was to form the sludge into large, ragged, feathery flocks as large as the end of one's little finger that fairly seemed to fall from suspension like sand.

These experiments looked so promising that during the winter of 1916-17 arrangements were made to carry out a plant sized experiment.

At the point of discharge of the mixing chamber into the settling basin a 6 in. centrifugal pump was set up coupled to a spare 10 H. P. motor. Its suction was dropped into the settling basins at a point where the sludges accumulated to the greatest depth and connected to a line running lengthwise of one section some 100 to 120 ft. long, bored with 1 in. holes on alternate sides of the horizontal diameter and spaced so as to be 1 ft. apart on alternate sides of the pipe, i. e. a hole every 2 ft. apart on either side. The pump was further arranged to discharge into the mixing chamber at a point some 4 to 6 passes from its place of discharge into the settling basin.

Several runs were made with this pump so arranged the results of which proved largely confirmatory of the preliminary laboratory experiments especially as regards its effectiveness in the winter months versus the summer months as regards the importance of the volume of sludge in contact with the water under treatment to realize marked results.

It was one of the expectations of such a treatment that with a water so reduced in alkalinity and normal carbonate content there would be a diminishing of the drop in alkalinity on passing the filters that would be strong evidence of the stable character of the water so produced and be strongly in contrast with our usual experience.

To this extent the process was encouraging but proved unfavorable on the following considerations:

(A) Because of the difficulty of getting a constant supply of sludge and of getting it in sufficient amounts.

It was assumed that the sludge could be made to travel somewhat as a belt that it could be lifted into the mixing chamber where it would do its work only to deposit rapidly again, the suctions being laid in a place thought to be most favorable for such abundant redeposit especially in view of the fact that it was constantly being added to by the newly treated water. Actual pumping however soon showed our inability to supply sludge at a rate greater than to get an application of more than 5 to 7 percent by volume of the sludge and for a period of more than 1 to 1½ hours at a time, when in the midst of plenty we would run out of sludge entirely.

Sludge could be pumped each time till there had been produced about each suction hole a more or less cleared area after which the sludge would cease to come and the experiment for the day would have to be terminated till such time as the sludge had again been built up. The sludge absolutely refused to flow to the pump suctions and the permanent adoption of such a scheme seemed dependent on the use of some device that would either bring sludge to the suctions or through the use of a Dorr Thickener or else the devising of some type of traveling or flexible suction that would follow up the sludge. Neither of these schemes seem impossible of solution.

(B) The production in the water of a finely divided suspended matter both difficult and expensive to remove by the use of alum—procedure hardly to be considered in view of the fact that the whole object of the scheme would be defeated in that it was the desire to conserve our alum.

The production of this finely divided suspended matter was at variance with the laboratory experiments and is somewhat difficult to explain unless the mechanical action on the sludge as it was drawn through the many suction holes and thrased about in the pump impellar were responsible, though there is to be set against this idea the fact that water dipped from the mixing chamber just at its time of discharge showed the same large ragged flocs that were produced in the laboratory with air agitation, and the same tendency to rapidly settle. It was also impossible to get sludge runs long enough to gain an idea of just how such a water would act on the filters either to rapidly increase the loss of head, the amount of wash water, or how it would interfere with the quality of the effluents.

No agitation was used in the plant sized experiments other than that afforded by the normal baffling of the mixing chambers, this point again checking the laboratory findings of the comparative importance of the volume of the sludge used rather than the length of time in contact.

It is difficult to state with sureness any exact explanation of these phenomena. It would appear that they are largely mechanical in that the sludge made use of contains no residual chemical activity, in that the sludge apparently acts to scour out colloidal matter as evidenced in the reduction of the magnesium content of the water as was further evidenced in the apparently greater efficiency to so do when applied to the water that has its lime reactions most nearly completed, and finally as evidenced in the fact that the reduction in the normal and total alkalinity must come about through the introduction of the many crystals of calcium carbonate that act as foci for the more rapid formation of such crystals than normally takes place.

TABLE IV.

Water taken from [illegible] of the mixing chamber after [illegible] application [illegible] temperature of [illegible]

	T[illegible]	P[illegible]	[illegible]alk.	N[illegible] carb.	M[illegible]
Water unsludged	[illegible]	[illegible]	[illegible]	56	[illegible]
[illegible]% sludge by vol. [illegible] minutes	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5% sludge by vol. 10 minutes	[illegible]	[illegible]	[illegible]	24	[illegible]
1[illegible]% sludge by vol. [illegible] minutes	[illegible]	[illegible]	[illegible]	24	[illegible]
[illegible]% sludge by vol. [illegible] minutes	[illegible]	[illegible]	[illegible]	22	[illegible]
[illegible]% sludge by vol. [illegible] minutes	[illegible]	[illegible]	[illegible]	15	[illegible]
[illegible]% sludge by vol. [illegible] minutes	[illegible]	[illegible]	[illegible]	18	[illegible]

Cost of Sewage Pumping at Newton, Mass.—[illegible] the sewage pumping station of Newton, Mass., handled 25,214,500 gal. of sewage, at a total cost of $2,242, according to the last annual report of E. H. Rogers, City Engineer. This total includes the following items: Gasoline, $309; electricity, $518; other expenses, $1,424. The gasoline consumed amounted to 1,235 gal. The plant comprises two 2½ in. centrifugal pumps operated by two 6 h.p. gasoline engines and one 4 in. centrifugal pump operated by a 10 h.p. motor. The pumping station cost $6,700.

Chloramine*

[illegible] HARNES

[illegible] commonly overlooked. Chloramine (chloramine, monochlora-[illegible] by treat[illegible] with dilute ammonia [illegible] equation.

$NH_3 + NaOCl = NH_2Cl + NaOH$

[illegible] in equivalent [illegible] decomposition, liberation of nitrogen or reversion to ammonia is [illegible]. If calcium hypochlorite in equivalent amounts be substituted for sodium hypochlorite the reaction may be thus understood: [illegible] Ca(OH)₂. With [illegible] tendency to produce nitrogen trichloride and nitrogen.

[illegible] of only relatively low concentration can be prepared; that if stronger solutions of bleach and of ammonia are used, the reaction must take place in the presence of considerable amounts of diluting water.

Experiments were undertaken to determine the stability of chloramine solutions of different strengths. Two methods of determining the velocity of the reaction: (1) The content of chloramine remaining in the solution after the lapse of each period of test, and (2) the total volume of nitrogen evolved in a gas burette at the end of each period.

[illegible] A CHLORAMINE SOLUTION

Hours.	Chlorine—parts per million.	Cubic centimeter. Nitrogen evolved from 50 cc. sol.
[illegible]	[illegible]	0
[illegible]	1003.443	
[illegible]	1003.443	0
[illegible]	1003.443	[illegible]
[illegible]	[illegible]	0.01
[illegible]	[illegible]	0.05
[illegible]		[illegible]
[illegible]	[illegible]	0.12
[illegible]		[illegible]
[illegible]	[illegible]	
[illegible]		[illegible]
[illegible]		0.27
[illegible]	[illegible]	
[illegible]	879.52	
[illegible]		0.37
[illegible]	[illegible]	
[illegible]		[illegible]
[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	
[illegible]		0.63
[illegible]		0.69
[illegible]	841.28	
[illegible]		[illegible]
[illegible]	707.44	
[illegible]		1.6
[illegible]	[illegible]	
76		2.5
[illegible]	430.20	
[illegible]		3.25
[illegible]	[illegible]	
[illegible]		[illegible]
170	213.00	
[illegible]		[illegible]

[illegible] is a function of the rate [illegible] which finds expression [illegible]

$NHCl = N + NHCl + HCl$

A series of determinations was made of the rate of decomposition of chloramine solutions of different strengths:

[illegible] SOLUTIONS

Hours.	Available chlorine. Ppm.	Available chlorine. Loss.	Available chlorine. Ppm.	Available chlorine. Loss.
0	10200	[illegible]	8160	0
1	[illegible]	28.68	7388	9.46
2	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	37.13	6619	18.88
[illegible]	[illegible]	[illegible]	[illegible]	33.36
11	[illegible]	82.90	2194	45.76
24	[illegible]	[illegible]	[illegible]	73.11
32.5	[illegible]	[illegible]	1819	77.71
53.5	[illegible]	97.06	469	93.03
Series [illegible]				
[illegible]	[illegible]	[illegible]	[illegible]	0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	14.21	[illegible]	10.83
[illegible]	[illegible]	[illegible]	2516	13.82
[illegible]	[illegible]	[illegible]	3169	[illegible]
11	[illegible]	38.10	2897	29.09
24	[illegible]	64.46	2016	50.59
32½	[illegible]	74.87	1603	60.71
[illegible]	[illegible]	90.80	863	78.85
[illegible]	3060	0	2040	0
[illegible]	2775	9.31	1875	8.09
[illegible]	[illegible]	11.76	1844	9.61
[illegible]	[illegible]	[illegible]	1813	11.13
[illegible]	2391	21.86	1706	16.37
[illegible]	2231	[illegible]	1638	19.71
[illegible]	1688	[illegible]	1350	33.82
[illegible]	[illegible]	54.35	1194	41.47
[illegible]	[illegible]	72.12	[illegible]	57.69

The most concentrated solution used (10.2 grains available chlorine per liter or .2877 normal) foamed vigorously at the start; the succeeding one less and so through the several series, with the velocity of the decomposition diminishing in each case as the period of experiment was prolonged, as indicated both by the volume of gas evolved and the concentration of available chlorine. A precipitation of calcium hydroxide varied in the series of reactions from very heavy in the first to relatively slight in the last.

From these data it is apparent why the application of chloramine should be made under such conditions that the concentration of the mixed reagents shall not exceed 1 part per million. A solution even of this low concentration should not be stored longer than 24 hours and is best made up as used. Not only do hydroxyl ions in solutions prepared from bleach and ammonia reduce the stability of chloramine; their reaction with bicarbonate ions in the treated water convert the latter to bivalent carbonate ions, and cause a copious precipitation of calcium carbonate.

$OH + HCO_3 = H_2O + CO_3$

This has resulted in incrustation of feed pipe and of lines carrying the treated water from the point of applying chloramine.

Some experiments were carried on in preparing chloramine with dilute chlorine water and dilute ammonia compounds, NH_4OH, $(NH_4)_2$, CO_3, etc., with varying results. While it is theoretically possible that some chloramine might be formed under these conditions, the diverse possibilities of reaction, indicated by Bray and Dowell (J. Am. Chem. Soc. 39, 905), offer little hope that direct addition of ammonia and liquid chlorine to a water can be so controlled and distribution of the sterilizing agent made so efficient as to insure the full chlorine equivalent in chloramine.

Rideal (J. Roy. San. Inst. 31, 33, 1910), found that when chlorine was introduced into sewage it was rapidly consumed, but that after free chlorine had entirely disappeared there persisted a strong germicidal power. The same results were obtained when bleaching powder was added to a water containing a small amount of ammonia. It seemed probable that the ammonia did not increase the oxidizing power of chlorine, since readily oxidizable organic matter in water absorbed much less chlorine from ammonia and hypochlorite than from hypochlorite alone. Furthermore the bleaching effect on dystuffs indicated that ammonia and bleach together had only 2 per cent of the oxidizing (bleaching) power of hypochlorite alone. While chloramine has little oxidizing value it is still able to displace iodine from potassium iodide, giving the usual starch-iodide reaction; its chlorine can be precipitated by silver nitrate, and its ammonia equivalent determined with the strongly alkaline Nessler's reagent. Rideal showed that chloramine has a phenol coefficient of 6.6 three times that of chlorine.

According to Dakin (Proc. Roy. Soc. Lond. Series B 89, B. 164, pp. 232-251) the germicidal value of hypochlorite in sewage is due to chloramine derivatives produced by the action of chlorine on amino acids and proteins. The proteins present in sewage contain amino groups which may react with chlorine to form substituted chloramines containing the NCl group. When chlorine or bleaching powder is added to sewage, there may occur a primary oxidation and a secondary formation of toxic chloramines from the reaction of amino-bodies. When chloramine is added to sewage the initial rapid oxidation is eliminated, and the germicidal action begins at once. Dakin attributes the latter action to the chloramine group.

It is possible that proteins of living cells may so react, and that the killing of micro-organisms by hypochlorites is due to chemical changes of this character within the living cell, either by direct action of the germicide or by secondary products or similar nature.

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*[illegible] at the annual meeting of the [illegible] Association.

Water Charges in 51 Cities of 9,000 to 10,000 Population

Interesting information on the water service in cities of 9,000 to 10,000 population has been collected by Mr. Kenyon Riddle, City Manager of Xenia, Ohio. A questionnaire was sent to all cities of the United States of the above size and replies were received from 43. Information on eight Ohio cities was obtained from the Bureau of Inspection and Supervision of Public Offices of that state. The average charge for the 51 cities for water to private consumers, based on 40,000 gal. per year, was $8.75; the average lowest rate per 1,000 gal. per quarter was $[illegible]. The average per capita charges were:

Gross returns	$3.25
Fire protection	.27
Total public service charge	[illegible]

Table I summarizes the information from the 51 cities.

TABLE I—COST OF WATER SERVICE IN 51 CITIES OF FROM 9,000 to 10,000 POPULATION.

Name of City.	Present value of entire plant.	Date of installation.	Cost of water for fire protection	Total public service charge.	Cost of 10,000 gal. in a year.	Lowest rate per 1,000 gal., per quarter.	Per Capita Charges— Value of water works	Gross returns	Fire protection	Total public service charge.
[1]Xenia, O. (P)	$260,000	1887	$13,800	[illegible]	[illegible]	$0.159	[illegible]	$5.50	$1.53	$1.70
[2]Aberdeen, S. D. (M)	224,500	1885	*	*	5.90	.06	13.50	1.30	*	
Fostoria, O. (M)	....	1892	*	*	7.90	.07	....	2.68	*	
[4]Emporia, Kan. (M)	400,000	1885	*	1,500	7.25	.06	40.00	4.60		.15
[2]Corsicana, Tex. (M)	160,000	1895	6,325	6,325	16.00	.20	12.00	....	.45	.45
[4]Iola, Kan. (M)	123,000	1900	*	*	6.23	.04½	12.30	2.36		
Hastings, Neb. (M)	250,000	....	7,000	7,845	9.10	.13	20.00	3.30	.58	.62
Westerly, R. I. (M)	[illegible]	1897	3,578	3,578	10.00	.10	35.00	4.20	.35	[illegible]
Ludington, Mich. (M)	[illegible]	1881	6,000	8,000	[illegible]	.10	20.00	2.50	.60	.80
Rahway, N. J. (M)	350,000	1871	*	*	.....	.06	35.00	4.52		
[7]East Cleveland, O. (P-M)	....	....	*	4,400	4.30	.107	.....	.....	.18	.18
[5]Monmouth, Ill. (M)	300,000	1890	*		14.00	.....	30.00	2.50	*	
Junction City, Kan. (M)	200,000	1887	4,550	8,550	[illegible]	.05	25.00	3.70	[illegible]	1.00
Fort Scott, Kan. (M)	[illegible]	[illegible]	[illegible]	6,120	10.00	.09	21.00	2.65	.50	.50
Kewanee, Ill. (M)	[illegible]	1917	[illegible]	10,000	13.20	.16	23.00	1.50	[illegible]	.58
Granite City, Ill. (P)	...	1892	[illegible]	5,300	5.80	....		...	.27	.30
Hopkinsville, Ky. (P)	..	1895	[illegible]	5,310	12.00	..	...	..	.48	.48
Sanford, Me. (P)		1885	2,400	1,500	6.00	.68		2.70	[illegible]	[illegible]
Delaware, O. (P)	300,000	1888	11,280	12,000	10.40	.10	33.00	...	1.24	1.30
Owosso, Mich. (P)	150,000	1889	[illegible]	6,066	8.80	.087	19.00	2.75	.44	.55
[3]Tyler, Tex. (M)	285,000	1917	*		..	....	19.00	.....	*	
Defiance, O. (M)	150,000	1888			12.00	.08	16.60	..		
St. Charles, Mo. (M)	150,000	1901			6.00	.08	15.00	2.50		
[10]Abilene, Kan. (M)	80,000	1897	3,000	3,500	7.50	.05	16.00	4.40	[illegible]	.70
[10]Herington, Kan. (M)	90,000	1914	1,500	1,700	[illegible]	.10	19.00	2.50	.30	[illegible]
Albuquerque, N. M. (M)	[illegible]	1885	[illegible]	5,313	12.00	.15	22.00	4.20	[illegible]	.29
[5]Pomona, Cal. (P)	500,000	1896	*	1,200	6.00	.10	31.00	4.95		[illegible]
Clarksville, Tenn. (M)	200,000	1912		*	10.00	.12½	20.00	2.00	*	
Brunswick, Ga. (P)		[illegible]	[illegible]	[illegible]				1.50	.16	.17
Arkansas City, Ark. (M)	200,000	[illegible]		*	7.20	.06	[illegible]		*	
Chickasha, Okla. (P)	240,000	1904			7.20	.05	16.00	3.15	*	
Santa Ana, Cal. (M)		[illegible]			5.20	.03		3.00		*
Goshen, Ind. (M)	[illegible]	1870	[illegible]	[illegible]	4.80	.05	22.00	3.04	.20	[illegible]
Bellefontaine, O. (M)		1884		*	6.00	.10		2.40	*	
[4]Billings, Mont. (M)	500,000	1883	*		8.00	.05	28.00	5.12	*	
[6]Ashland, Wis. (P)	480,000	1884	24,445	[illegible]	6.00	[illegible]	[illegible]	5.30	1.70	[illegible]
Anaconda, Mont. (P)			[illegible]	[illegible]			....		.33	[illegible]
[5]Barre, Vt. (M)	390,000	1887	2,860	3,300	8.00	.045	33.00	2.90	[illegible]	[illegible]
Virginia, Minn. (M)		1892		*	[illegible]	.10		2.50	*	
Menominee, Mich. (M)	[illegible]	1884			7.60	.10	[illegible]	4.00	*	[illegible]
Ottawa, Kan. (M)	[illegible]	1886	[illegible]	5,680	10.00	.05	14.40	2.80	[illegible]	[illegible]
[4]Adrian, Mich. (P)	150,000	1882	16,100	20,000	18.00		12.50		[illegible]	[illegible]
Abilene, Tex. (P)		1898	[illegible]	3,800	10.00				.25	[illegible]
Medford, Ore. (M)		1909	[illegible]	[illegible]	[illegible]	.10		[illegible]		
Ashland, O. (M)	....	....	*			...			*	*
Coshocton, O. (M)										
Niles, O. (M)	....	....	*							
Norwalk, O. (M)	....	....	*						*	
Salem, O. (M)		..		[illegible]					*	[illegible]
Urbana, O. (M)	....	....	*							
Wellsville, O. (M)		.	*						*	

Source of Supply: [1]Wells and [illegible]. [2]Artesian wells. [3]Reservoir. [4]Rivers. [5]Wells. [6]Lake. [7]From city of Cleveland. [8]Deep wells. [9]River and two deep wells. [10]Springs. [11]Mountain Stream. [12]Green Bay, Michigan.

*No cost to city for public service. (P) Private ownership. (M) Municipal ownership.

Operating Results of Dover, N. H., Waterworks for 1918

The cost of supplying water by the water works of Dover, N. H., for 1918, figured on total maintenance and operation, was $84.71 per 1,000,000 gal., according to the last annual report of Henry E. Perry, superintendent. The total pumpage for the year was 238,628,000 gal. by meter measurement. The average pumpage per day was 658,209 gal.; the highest pumpage was in February—821,536 gal. The total pumping hours for the year was 2,498. The average static head against which the pumps work is 168 ft., and the average dynamic head is 185 ft. The number of gallons pumped per K.W. hour of electricity was 1,000. The cost per 1,000,000 gal. pumped was $35.34; per 1,000,000 gal. raised 1 ft. (dynamic) the cost was $0.19. The total amount of electricity used for pumping was 237,816 K.W.

The estimated population of the city was 15,000, of which 14,000 obtained their supply from the city water works. The percentage of consumption metered was 42.5 per cent, there being 1,602 meters in use. The number of services was 1,990, and the number of hydrants 227. The per capita consumption was 45.3 gal.; the supply per tap was 330 gal per day.

The total receipts for 1918 were $38,298, and the total operating expenses were $20,215. The latter figure covers maintenance and operation and includes the following items:

Filter beds	$ 773
Damage and litigation	482
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
Pipe shop	151
Pumping station	8,435
[illegible]	[illegible]
Service piping	1,541
Pond station	1,428
[illegible]	[illegible]
[illegible]	[illegible]215

The pumping station costs were:

[illegible]	[illegible]
[illegible]	472
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	5
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	32
[illegible]	15
[illegible]	154
[illegible]	[illegible]

The water works were built in 1888-9 and the total cost to date has been $[illegible].

Methods and Costs of Constructing a Small Tunnel for Irrigation Canal

By [illegible]

([illegible] Service)

The [illegible] is a small tunnel on the line of [illegible] a part of the system built by the [illegible] Service. The work was done by [illegible]. The length is [illegible] from portal to portal. The [illegible] lined, [illegible] ft. wide by 4 ft. 6 in. high [illegible]. The [illegible] of 9 in.

The first [illegible] of each heading was decomposed rock [illegible], and excavation was made by picking out the softer [illegible] by means of crow bars. When harder rock was reached, holes were drilled by hand [illegible] per cent [illegible] gelatin dynamite. At [illegible] the rock was [illegible] hard so that not more than 4 or 5 ft. of hole was drilled by each pair (drill holder and striker) during a 10-hour shift. But the holes drilled were fired at the end of each shift and the next shift started new holes. In this way it was possible to take advantage of the numerous seams in the rock and fewer holes and less explosive were used than would have been necessary if a "round" of holes had been drilled to pull the whole face.

The work was carried on as nearly continuously as local conditions would permit. Two shifts of 10 hours each al[illegible] escape. No work was done on [illegible] important "feast days." There were frequent occasions when for one reason or another not enough men showed up to work a shift, and occasionally the whole crew would strike for higher pay and no work would be done for 3 or 4 days.

The sequence of operation in the tunnel was: An hour or two after each blast, the men of the new shift went in to the heading and began picking down all loose rock in the face and over head. If needed, a set of square timbers was placed to support the roof. Posts and caps were 6x8 in. [illegible] 2x8 in. or 2x10 in. plank was used. The drillers then started drilling and two laborers removed the muck in 1 yd. revolving dump cars. The loading and hauling was all done by the two muckers, except that when an unusually large quantity was to be removed, another man was required. The numerous seams in the rock were filled with a very fine unctuous clay which caused large pieces of rock to fall very unexpectedly sometimes. To avoid this, practically the whole roof of the tunnel was supported by temporary timbers, until the concrete lining was placed. In a few places the ground became so soft that the timbers were not removed but were encased in the concrete. Monthly progress of excavation for each heading is shown below:

[illegible]	West heading, ft.	East heading, ft.
[illegible]	[illegible]	
October	50	
[illegible]	1	11
December	22	55
[illegible]	[illegible]	47
[illegible]	18	52
[illegible]	[illegible]	63
[illegible]	[illegible]	46
[illegible]	[illegible]	304

The tunnel was lined with concrete made of portland cement, and broken stone from the tunnel, hand mixed in proportions 1:3:6. A mixing platform was built on the dump near each end of the tunnel, and alongside the portable track. The broken rock was loaded into wheelbarrows, which served for measuring and wheeled to the platform. After mixing, the concrete was shoveled into cars. The car bodies were wooden boxes 1 ft. deep, built of 2 in. plank to rest on the trucks of the revolving dump cars. The dump body was removed and the flat box placed on the truck whenever concrete was to be hauled. One end of the car box was made to slide between cleats on the side boards, so that the end could be removed to facilitate shoveling the concrete from the cars to the forms. Side wall forms were made in panels 9 ft. long, using boards 1½ in. thick. The first two boards from the bottom were nailed to 2x4 in. uprights 4½ ft. high, the height of the side walls. The remaining boards were placed one at a time as the wall was built up, these were not nailed but were held in place by the pressure of the concrete. Each pair of uprights was held apart by a pair of spreaders, 2x4 in., one at the top and one at the bottom. After the concrete had set for not less than 24 hours, the side wall forms were removed and arch forms placed. These were made in sections 3 ft. long. Two ribs were cut from 1½x12 in. boards and worked to the proper radius. Lagging 2 in. by 3 in. by 3 ft. was nailed to these ribs to make a section of form. As each 3 ft. section was placed, the concrete was shoveled upon it from the open end, and rammed into place by a 2x4 tamping stick. The arch and side walls are 9 in. thick. All space between concrete and the rock was carefully packed with stone.

When concreting was started, only one gang was used, placing first the side walls and then the arch. After excavation was completed, the remaining concrete was placed by two gangs, one working on side walls and the other placing the arch. After the sides and arch had been completed, the track was taken up and a 4 in. concrete floor was placed through the entire length of the tunnel. Near the west end, a 50 ft. section was in such hard and apparently solid rock, that side walls and arch were omitted from this portion.

Details of cost are shown below:

PORTAL CUT EXCAVATION, 2,290 CU. METERS.

(Cubic meter equals 1.3 cu. yd.)

	Total.	Per unit.
Labor, excavation	$1,069	$0.467
Labor, drilling and blasting	127	.055
Labor, haul	850	.371
Labor, miscellaneous	303	.132
Supplies	[illegible]	.029
Explosives	41	.018
General expense	195	.085
Total	$2,662	$1.15

TUNNEL EXCAVATION, 659 CU. METERS.

	Total.	Per unit.
Labor, drilling and blasting	$1,[illegible]	$2.[illegible]
Labor, laying and repairing track	57	.086
Labor, mucking	557	.847
Labor, haul	[illegible]	.328
Labor, miscellaneous	742	1.128
Supplies	358	.544
Explosives	329	.501
Blacksmith shop	388	.592
General expenses	545	.828
Timbering, labor	110	.167
Timbering, materials	201	.305
Total	$5,765	$8.744

CONCRETE LINING, 223.6 CU. METERS.

	Total.	Per unit.
Labor, prep. and genl.	$ 163	$0.726
Labor, forms	27	.119
Labor, mixing	260	1.160
Labor, hoisting and placing	301	1.348
Labor, tracking	11	.065
Labor, hauling and screening stone	266	1.188
Labor, miscellaneous	192	.858
Cement cost	612	2.730
Cement haul	86	.382
Materials and supplies, miscellaneous	45	.202
Materials and supplies, forms	53	.237
Repairs	10	.043
General expenses	177	.791
Water cost	149	.667
Refill	103	.459
Total	$2,459	$10.976

The total cost of excavating and lining tunnel, 600 ft. long, was $8,224, or $13.71 per lineal foot.

Net Water Revenue at Duluth Increased 25 Per Cent in 1918

In his annual report for 1918, Mr. D. A. Read, Manager of the City Water and Light Department of Duluth, Minn., calls attention to the fact that the total amount of water pumped was 2 per cent less than the previous year, while the net water revenue increased 25.2 per cent with exactly the same rates and with an increase of salary for nearly every employe. This, he stated, has been partly accomplished by an increase in the meterage from 93.2 per cent in 1917 to 94.2 per cent in 1918. He adds that while some of the reduction in pumpage was accomplished by repairing leaks, notably one at the ship canal crossing, where the leakage was reduced from 18 cu. ft. per minute to 6 cu. ft. per minute, still the larger saving has undoubtedly been effected by the change in method of paying for water. Under the flat rate system a customer has no direct incentive to save water or prevent waste. It is true that it is or should be to the general interest of all that each individual should save in order to lessen the burdens for all, but to most individuals this is an intangible saving that does not readily appeal to the understanding.

POWER AND PUMPING SECTION

This section of the Waterworks and Hydraulic Monthly issue of Engineering and Contracting is devoted to the selection of power and pumping equipment and the economic management of its operation.

An Effective Yet Simple Bonus System for Power Plants

In the early part of 1915 the management of the Manila Electric Railway had under consideration the inauguration of a bonus system of wage for the employes of the power plant, with a view to arousing in them more enthusiastic interest in fuel saving, which would lead to a lower unit cost of electrical energy generated. A 48-hour economy test of the power plant was made to determine the distribution of the heat losses and that available for conversion into electrical energy. The test, with all the accompanying specifications, instructions and data to be obtained, was planned by the J. G. White Management Corporation, the operators of the Manila property. From a study of the data and results obtained from this test it was evident that considerable saving in fuel was possible without going to any great expense for improved equipment, by securing more careful, intelligent and efficient service from the power plant employes. As a consequence a bonus system was devised by Mr. B. H. Blaisdell, Chief Engineer, Power Plant of the company, that has given most gratifying results. The system is described by Mr. Blaisdell in Aera, to which we are indebted for the matter in our article.

With the exception of most of the engineers, all the employes are Filipinos who have obtained their experience and training almost wholly in the plant. To make these men more progressive and efficient and less dependable on the limited supervision of the engineers, it was evident that some special form of monetary reward for meritorious service must be adopted.

A simple increase in the weekly wage was certain to fail in bringing about any great or especially lasting improvement in economy. The reward must be in proportion to the service rendered in the saving of fuel, in order to bring about the results desired.

Employes Reap Benefit.—With this object in view the management offered the power plant employes beginning June 1, 1915, one-half of the value of the fuel saved due to effort on their part, the distribution of the bonus to be made monthly to cover such saving as had been accomplished during the preceding month.

Notices were posted explaining carefully every detail of the plan by which it was possible for the employe to earn extra compensation for his ability to save coal and decrease the cost of coal to the company.

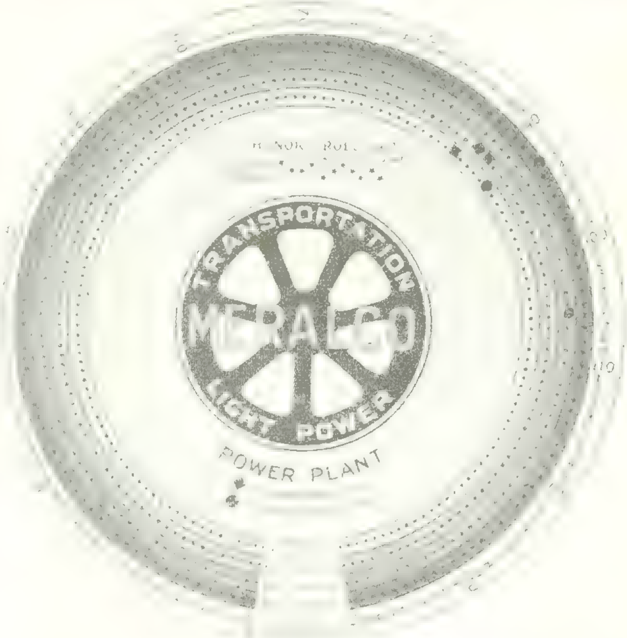
The standard of fuel efficiency on which a saving was to be reckoned was set at 41,000 B. t. u. (British thermal units) per switchboard kilowatt hour generated, this being the average efficiency obtained during the 48-hour plant test above referred to.

It was only fair and proper that the saving in fuel be computed on a B. t. u. basis, since the company purchases its coal on this basis, all cargoes received being sampled and the heat value determined by an outside and neutral testing laboratory.

Who Participate.—With the exception of the engineers, the distribution of the bonus was made to include all the power plant employes, numbering about 80 whether or not their duties were directly connected with the consumption of coal or the generation of steam, as an incentive not only to improve the boiler plant efficiency but to keep the electric generating equipment in the best condition for safe and economical operation. In the plan of bonus system, when first bulletined for the information of the employes, strong emphasis was laid on the fact that the operation of the plan was contingent upon the continuous, efficient and economic operation of the power plant, with respect to the throwing in or throwing out of the various units, or the overloading of same to their detriment, in-so-far as the life, the cost and the upkeep of such units would be affected by wrong practices indulged in in order to save coal, as, under no circumstances or conditions, would the operation of the bonus system be permitted in any way to affect the reliability and continuity of the electric service furnished the public.

Although all the employes participate in the bonus, the proportion received by each varies with their responsibility or the degree in which their duties offer an opportunity to save fuel.

Penalties Also Provided.—Profiting by the experience of many companies that have adopted a bonus system of wages only to have it meet with dismal failure in a few months on account of trouble arising of a more or less serious nature solely because no provision had been made to retain discipline, the company provided against such a contingency by supplementing the bonus with penalties, the latter to be inflicted on employes breaking the established rules of proper conduct.



Bonus Dial.

[illegible] Perfect Operation Will Earn Revenue, "A little coal on the grate makes the furnace hot; a ton of coal under the grate makes economy naught"; "Saving coal at the expense of reliable service [illegible]

The plan as carried out credits each employe with a certain number of bonus points per day according to his position and opportunity to improve plant efficiency; for instance a water tender receives 10 points, a fireman 6 points, an oiler or coal passer 3 points, etc., through all the different classifications of employes. Should, however, an employe break a rule or otherwise misbehave, he is immediately disciplined by being penalized according to the magnitude of his offense. Absentees from duty do not receive points.

A daily record of the points received by each employe is posted where he can readily see whether he has succeeded in winning all the points he is entitled to for satisfactory service.

[illegible] during [illegible] earned [illegible].

[illegible] but rather [illegible] each [illegible] fuel saving. [illegible] a sport[illegible] each to [illegible] consumption per kilowatt hour, as compared to the best previous [illegible] their bonus [illegible] best showing.

[illegible] Bonus Dial.—The relative standing of the "watches" [illegible] a period from the beginning of the month to date is shown on a [illegible] dressing room. The information imparted keeps up a perpetual interest and enthusiasm in every one concerned to do his utmost to make his "watch" rank first in fuel economy so as to receive an extra share of the bonus as hereafter described.

[illegible] and is painted near its outer edge with four circular stripes of different colors. The black, green and blue stripes, each represents the gage of efficiency of one of the "watches," while the red stripe is the average gage of efficiency for the combined "watches."

A scale denoting the per cent saving in fuel circumscribes the stripes, the latter being perforated at points corresponding to 1-10 of 1 per cent divisions of the scale; into the perforations plugs are inserted two for each stripe.

Round headed plugs are inserted at a point in the stripes opposite the scale reading which corresponds with the average per cent saving in fuel obtained from the beginning of the month, while square headed plugs are inserted at the point in the stripes so as to show the highest monthly record.

At the end of the month the "watch" obtaining the highest efficiency as shown by the relative position of its plugs wins 10 per cent of the bonus points of the "watch" showing the lowest efficiency as denoted by the position of its plugs. The "watch" obtaining intermediate efficiency receives the regular bonus.

The center of the disk is inscribed with the company's insignia together with appropriate mottos to encourage economical and reliable service, and an honor roll which indicates by the placing of a star each month opposite the name of the "watch" boiler room foreman winning the 10 per cent extra bonus.

It is doubtful whether top notch economy could be obtained without pitting one "watch" against the other, nevertheless herein lies possibilities of a very great damage to the success and permanency of a bonus system of wages.

Enthusiasm runs so high at times that it may be possible that overzealous men will attempt to accomplish by foul means what they fail to gain by fair means in order to win 10 per cent extra bonus for their "watch."

Offenses Punished.—To discourage much misdirected effort, prompt and energetic action should be taken in penalizing those guilty by depriving them of bonus points commensurate with their offense.

The chief engineer of the plant, on receiving complaints from his assistants against men under their charge, imposes the penalties, the men, however, have the right to appeal to the assistant general manager and from him to the general manager.

This method of discipline has proved very successful in improving the general deportment and service rendered.

Weighing the Coal.—One of the most important matters pertaining to plant operation that demands serious thought and study, is securing a proper check on the weighing of coal at the time it is being received and stored on the pile as well as when the coal is reclaimed from the pile for daily consumption.

The company employs a foreman, coal checker and a number of assistants who in conjunction with the coal company's checkers weigh the coal as it is being discharged from the barges. The chief engineer holds these men responsible for any shortage that subsequently may be discovered.

The weighing and registering of the barrows of coal delivered for consumption to the boiler plant is performed by the operating force of coal passers as they wheel the barrows across the coal scales, however, at all times under the watchful eye of a regular coal checker.

This double checking of the daily coal consumption by two opposing forces is very important, in fact necessary, for the coal checkers, being responsible for any shortage, watch the operating men closely that they abstract no coal in order to increase the apparent fuel efficiency and thereby their bonus.

That the results obtained in this respect are all that could be desired is affirmed by the fact that not one pound of shortage has occurred in the coal pile since the inauguration of the bonus system two and one-half years ago.

Increased Efficiency.—An improvement in fuel efficiency began to be realized immediately after the bonus system of reward for fuel saving had been established, and the economies subsequently obtained have been far greater than anticipated.

The firemen, who formerly were mere shovelers, gradually evolved into expert boiler operators, capable of distributing the coal at the right time in the right amount and in the right place, to keep an even fuel bed of the proper thickness to give the best results.

In the old method of firing each fireman had certain furnace doors to fire and the resulting efficiency obtained in the different boilers varied according to the ability and interest taken by the individual fireman attending them.

The improved method compelled the firemen to follow each other down the line of boilers, at periods depending on the load, firing alternate doors, thus ensuring equal furnace operating conditions in all the boilers and higher economy due to the controlling influence of the more experienced firemen in showing up and correcting the faults in firing of the less experienced men.

The water tenders learned to adjust the damper to admit only the necessary air to furnaces to economically burn the coal required for carrying the load. The frequent use of the Osat apparatus for testing the flue gases materially assisted in determining the most economical damper opening for different hourly load conditions.

The coalpassers became more careful at time of cleaning fires and ashpits that the least possible amount of coal was wasted in the refuse.

The repair men increased both the amount and quality of the work performed, especially in the matter of cleaning boilers.

It became the practice to carry the greatest output possible on the most economical generating units and auxiliaries and to limit the machinery in service to only that necessary to safely carry the load.

Saving in Fuel.—The actual saving in fuel based on 41,000 B. t. u. per kilowatt hour, the standard set June 1, 1915, when the bonus system of wages was established, has improved during successive six-month periods as follows:

Second half year 1915	5.5%
First half year 1916	12.3%
Second half year 1916	17.3%
First half year 1917	15.2%
Second half year 1917	(estimated) 18.5%

This remarkable improvement in fuel economy was not wholly due to extra effort on the part of the employes participating in the bonus system, but partly to improvements made in the plant, improved methods of operation and improved condition of equipment, largely due to the valuable engineering advice, instructions and co-operation of the J. G. White Management Corporation, the operators of the Manila property.

It would be perhaps fair to say that the results obtained were due to the efforts of the employes to the extent of approximately 50 per cent of the fuel economy effected, and approximately 50 per cent to the improvements in the plant and its operation for which the company is indebted to the J. G. White Management Corporation, the operators of the Manila property. The probabilities are that, if the bonus system was discontinued, the estimated saving in fuel, taken as approximately 50 per cent due to the efforts of the employes, would be lost.

Changes in Power Plant.—Some of the changes and improvements made by the company in the power plant equipment and the operation thereof since the bonus system became effective were as follows:

1. The application of additional heat insulating material

of asbestos and magnesia to the piping, boiler drums and turbine casing.

2. The installation of a combination draft gage on each boiler so located that the boiler attendants can be guided by the indication of the gage as to the condition of the fuel bed and the proper adjustment of the air supply to the furnace.

3. The daily log sheets were improved as to include all data necessary to enable the supervising force to detect defects in operation and effect improvements.

4. The vacuum obtained at the turbine exhaust nozzle was increased by reducing the resistance offered to the exhaust steam entering the condenser, by removing certain condenser tubes as to open up steam lanes to a large part of the condenser surface.

5. The practice of running extra auxiliary units for no other purpose than to safeguard continuity of service was discontinued without serious consequences.

6. Deflecting arches were installed in all the furnaces to effect more complete combustion of the highly volatile coal used.

The resulting economies obtained by the changes and improvements mentioned, necessitated from time to time a reduction in the standard basis of coal consumption on which bonus for fuel saving was computed, according to provisions formulated in paragraph 12 of the "Plan of Bonus System of Wages," given below.

Reason for Change in Bonus Basis.—While it was only fair to the company to lower the standard basis of fuel consumption at such times as improved efficiency had resulted from changes and improvements over which the men participating in the bonus had no control, yet it was necessary not only to take special care in explaining to all concerned the reasons for a change, but to select a time for putting the lower standard of fuel consumption in effect when operating conditions were most favorable to economy and least liable to materially lower the amount of bonus to any extent which might cause dissatisfaction or suspicion among the employes that the company was not giving them a square deal.

Notwithstanding the reductions made in the standard basis of computing the bonus totaling 12.2 per cent, the employes have enjoyed an increasing income therefrom, amounting during the year 1915 to an average of $400 per month or 23 per cent of their wages, during the year 1916 an average of $600 per month or 35 per cent of the wages, and during the year 1917 an average of $675 per month or 39 per cent of the wages. Occasionally the bonus distribution exceeds $800, but this amount rather proves too generous as the increase in wages derived thereby is greater than the average employe's standard of living requires, resulting in many remaining off duty or requesting vacation leave for a few days much to the inconvenience of the supervisory force and the resultant efficiency and reliability of the operation of the plant.

Results Are Gratifying.—The bonus system of wages has now been in operation for about two and one-half years with the most gratifying results.

The B. t. u. consumption per switchboard kilowatt hour at the present time is nearly 25 per cent less than it was three years ago. The present saving in fuel cost, based on the latest standard of fuel efficiency put in effect Sept. 1, 1917, is 8.75 per cent. The company and the employes are equal partners, sharing alike the results obtained from fuel saving, a procedure which escapes the criticism that is sure to arise when a company appropriates the lion's share.

While the management and especially the chief engineer of the power plant, has never wholly approved from a standpoint of principle the offering of a bonus or reward to employes as an incentive to put forth their best effort, the means employed in this plant with this end in view seems well justified, considering the great improvement in economy subsequently obtained and the benefits thereby derived by both the company and its employes.

PLAN OF BONUS SYSTEM FOR POWER PLANT EMPLOYES MANILA ELECTRIC RAILWAY & LIGHT CO.

(EFFECTIVE JULY 1, 1917.)

(1) The standard basis of coal consumption per switchboard kw-hr. shall be 3.15 lbs.

(2) The basis of 3.15 lbs. of coal consumed per switchboard kw-hr. output is based on a standard of 11,715 b.t.u. per pound of coal. This has been fixed on the results of the laboratory analyses made of Fushun coal used during the Power Plant economy test made March 3 and 4, 1915.

(3) The standard basis of coal consumption, in b.t.u., per switchboard kw-hr. output shall be 36,900 (11,715 b.t.u. x 3.15 lbs.).

(4) The coal consumed per switchboard kw-hr. output shall be determined by taking the actual weight of the coal consumed and adding thereto 1 per cent additional to cover possible errors or omissions in weighing, and possible losses of coal consumed in the pile by reason of spontaneous combustion, etc.

(5) Fifty per cent of the value of the coal saved under the basis of 3.15 lbs. consumed per switchboard kw-hr., based on 11,715 b.t.u. per lb. of coal, or 36,900 b.t.u. per switchboard kw-hr. output, determined by the coal consumed as per (4), is to be distributed to certain participating employes of the Power Plant Department as shown on Exhibit A.

(6) The chief engineer of the Power Plant, who is not to participate in the distribution of the bonus, is to determine the schedule of points to be allowed the different occupations of the different employes of the Power Plant, as per Exhibit B, based on the relative value of their services. The chief engineer of the Power Plant is also to establish a schedule of the penalties to be applied to the schedule of points.

(7) A record of all penalties imposed is to be made, and the employe affected is to be notified at the time the record is made. Employes are to have the right of an appeal from any penalty imposed—first, to the chief engineer of the Power Plant, next, to the assistant general manager.

(8) If found practicable, or desirable, the watch, in a given month, making a better record than the same watch made during a preceding month, all conditions of operation being taken into consideration, is to receive an additional bonus, to be determined by the chief engineer of the Power Plant, and the watch making the poorest showing in the same month, on the same basis, to be correspondingly penalized.

(9) Bulletin boards are to be provided to keep employes posted regarding the basis of the distribution of the bonus, how applied, and the standing of each employe with respect to his participation in the bonus, in so far as it may be practicable or desirable to bulletin such information. If practicable, the daily results, as affecting the different watches, should be posted for the information of the employes.

(10) The monthly distribution of the bonus is to be prepared by the Power Plant Department, verified by the Accountant Department, and completed at the earliest possible date following the last day of each month.

(11) The payment of the bonus on a day other than the regular weekly pay day, will be made at the earliest possible date following the last day of the month in which the bonus applies.

(12) The company reserves the right to change the basis of the distribution of the bonus in any way it sees fit, or to discontinue it entirely, if it so decides.

EXHIBIT A.

Occupations of Power Plant employes entitled to participate in bonus system of wages, effective March 1, 1916.

Pay roll classification. Item No.	Occupation.	Number of employes.
1	Sub foreman	1
1	Chief coal checker	1
1	Assistant coal checkers	[illegible]
1	Clerk	1
[illegible]	Oilers and cleaners	10
[illegible]	Switchboard tenders	[illegible]
[illegible]	Switchboard keepers	[illegible]
[illegible]	Firemen	[illegible]
[illegible]	Coal passers	[illegible]
[illegible]	Water tender	[illegible]
[illegible]	Boiler cleaners	[illegible]
[illegible]	Watchman	1
11	Other labor	[illegible]
[illegible]	Mechanics and helpers	[illegible]
	Construction and reconstruction	[illegible]
	Total	[illegible]

EXHIBIT B.

[illegible] of occupations of Power Plant employes [illegible] the distribution of the bonus [illegible] July 1, 1916.

Pay roll classification.	Occupation.	Schedule of daily points per [illegible]
	Sub foreman	[illegible]
	Chief coal checker	[illegible]
	Assistant coal checkers	[illegible]
	[illegible]	[illegible]
	Oilers and cleaners	[illegible]
	Switchboard tenders	[illegible]
	Switchboard keepers	[illegible]
5	Firemen	6
	Coal passers	[illegible]
	Water tender	[illegible]
8	Boiler cleaners	3
	Boiler cleaner foreman	[illegible]
	Watchman	[illegible]
11	Other labor	1
	Mechanic foreman	[illegible]
	Mechanic	[illegible]
	Mechanic helper	[illegible]
	Laborer	[illegible]
13	Construction and reconstruction	1
	Total	[illegible]

Methods for Reducing Coal Consumption; 20 "Dont's" for Firemen and Water Tenders

[illegible] of coal saved on [illegible] Traction Co. [illegible]

[illegible] will proceed when the [illegible] of combustion. The [illegible] oxygen in the ratio [illegible] oxygen and form a gas, chemically known as carbon dioxide, and it's symbol [illegible] with a proper amount of oxygen to convert all of the carbon into carbon [illegible] if the oxygen [illegible] not properly supplied to the carbon, either through a lack of sufficient quantity or through improper mixture, much of the carbon will not get its full supply of oxygen and will [illegible] one-half the [illegible] combine with the oxygen and forms carbon monoxide (CO). The heat produced by burning one pound of carbon with one-half the proper amount of oxygen is only 4,400 heat units, so it is very evident that it is important to supply sufficient oxygen for complete combustion

Now, the above statements must not be interpreted as meaning that the big thing is to get more air into our furnaces because some of the greatest losses in burning of fuel are caused by letting too much air into a furnace. The big problem then is the proper amount of air and its proper distribution to maintain a high temperature in the furnace. The combustion of coal in the furnace is in two stages; first, the burning or combustion and the distillation of the volatile matter that occur in the fuel bed; second, the combustion of the gasses that occurs just above the fuel bed, or between the fuel and the arch, in what is known as the combustion space. The way that air is admitted to the furnace and the way that the coal is fed to the furnace very materially effect the combustion of the fuel and the efficiency of combustion and involve one of the most complex problems in power plant operation.

Hand Firing Pointers.—[illegible] hand fired furnace the general rule should be, frequent and thin firing, keeping the fuel bed a uniform thickness, not permitting holes to burn through the fuel bed and not pile up large heaps of green coal in the furnace. When green coal is thrown on a hot bed of fuel, the heat almost immediately drives off the volatile gasses, which may for the moment be partially burned; but, due to improper mixture and supply of air, may be actually robbed of the oxygen they have combined with and be reconverted into soot which comes out through the boilers and goes up the stack, producing very dense clouds of black smoke. These conditions are not entirely avoidable but can be made much worse by careless firing, as by piling in a large quantity of coal without proper distribution and without proper regard for the air supply.

In the chain grate stoker, effort is made to uniformly supply a definite quantity of coal to the furnace and in such a position in the furnace that the volatile gasses, which are distilled out of the coal, passing under the hot arch, have an opportunity to come in contact with sufficient amount of oxygen that is supplied to the fuel bed to properly burn these volatile gasses. Air going up through the under surface of the chain grate should supply oxygen properly distributed to completely burn the fixed carbon and gasses in the coal.

Here, too, the same as in hand firing furnaces, there is great danger of neglect in permitting holes to burn through the fire, which admits too much air to the furnaces. Also there is the danger of feeding the coal in such a way that the coal and volatile gas do not ignite properly and the combustion arch becomes cold and the gasses are permitted to escape without completely burning.

You can readily see that the process of burning coal is a very complex one and what actually goes on in the furnace is not entirely known at this time. That is, the processes are so complex and the difficulty of analzying them are so great that scientists have not been able to reduce these processes to simple explanations, but there is at this time a great deal being done along this line. One of the most valuable publications on this subject is Bulletin No. 135, published by our Government by the Department of the Interior on the subject, "Combustion of Coal and Design of Furnaces."

Exclude Cold Air.—I mentioned above that too much air to the furnace is one of the greatest evils that we have to contend with. This is because all this extra air must be heated to the temperature of the furnace and heat taken up by this extra air escapes up the smokestack, thus wasting large quantities of heat. Generally speaking the most fruitful source of study on furnace combustion is that of eliminating the excess air. CO analyses of the flue gasses are very helpful in making a study of this kind.

It is important that boiler settings, that is boiler walls, shall be tight and not have openings in them because air will leak through and this air tends to cool the boiler and also carry off large quantities of heat. Air can actually pass through a brick, so the boiler walls should be built of brick that is not very porous, and it is better that they be coated over with the material to keep the air out.

Now, suppose we have done all we can to burn the coal in the furnace supplying the right amount of air and properly distributed, we should attain a very hot fire and the next process is to deliver the heat contained in the hot gas in the furnace to the water in the boiler. To do this the baffling between the boiler tubes should be in a condition so as to force the gasses around and among the tubes in the proper manner. In order that the water in the boiler may get this heat from the gasses the heat surrounding the tubes must pass through the walls of the tubes to the water inside. Iron from which the tubes is made conducts heat very readily, but the tubes may be coated inside or out, with material that will not conduct heat well. Ashes and soot from the coal are found on the outside of the tubes and scale from the water is found on the inside of the tubes.

Soot and Boiler Scale.—Soot is one of the best coverings possible to keep out heat. Wool and feathers, which nature have provided on animals and birds that have to endure the cold, are among the best materials to keep the body warm, but it is found that soot is almost as effective as wool or feathers. That is, if the body could be covered with a uniform thick coating of soot, it would keep us warm in winter, so it is proven that soot on a boiler tube is very effective in keeping the heat from the fire out of the water, and it is very important to keep the outside of the boiler tube clean from soot and ashes.

On the inside of the boiler tube, the water forms a scale because the water boiling away in the boiler leaves behind a solid matter which coats the boiler tube. Boiler scale may be porous and thus not retard so very much the passing of the heat into the water or it may be very hard and form a hard coat on the inside of the tube and thus seriously prevent the heat from passing into the water. When a boiler tube is burned and blisters and a small hole blows through the tube, the hole is caused by the scale on in the inside of the tube keeping the water away from the tube and the hot gasses of the furnace heating the tube so hot that it becomes soft and then the pressure in the boiler blows the hole through the tube. Therefore, it is very necessary for economical and safe operation to keep the boiler tubes clean as possible inside and outside.

Boiler and Pipe Covering, Etc.—It is important that all exposed surface of the boiler drum and steam pipe be covered. Magnesia is one of the most effective coverings for this purpose. The reason for covering steam piping and exposed portions of the boilers is to prevent the cold air of the boiler room coming in contact with the hot iron of the boiler and piping that contains the steam. The steam has a temperature of about 366 degrees, whereas air in the boiler room may have a temperature of from 60 to 120 degrees. The air, therefore, on the outside of the pipes condenses the steam on the inside of the pipes, and each square foot of exposed pipe may cost one-half ton of coal a year.

It is evident to all of us that leaks of various kinds are very wasteful and one of the most serious of these is leaking blow-off valves. The blow-off valve is rather hard to keep tight because of the scale that gets in the valve constantly giving trouble in maintenance. Another source of loss is leaks in the boiler that blow inside the boiler setting that you cannot see or hear.

A very important possible source of economy is to feed the water into the boiler as hot as possible. Steam from auxiliary pumps and condensers should be used to heat the boiler feed water Any heat supplied to the boiler feed water saves an equal quantity of heat that would otherwise be supplied from the furnace. Heating the water in a feed water heater also helps to purify the water and reduces the scale formation in the boiler. Roughly speaking, for about each 11° that the boiler feed water is heated, about 1 per cent is saved in coal.

Do Not Waste Coal in Boiler Room by Having:

1. Holes in the fire.
2. Irregular thickness of fuel bed.
3. Fires too heavy.
4. Too much fuel in the ashes.
5. Too many boilers in service.
6. Improperly banked boilers.
7. Improper operation of boiler dampers.
8. Irregular steam pressure.
9. Air leak in the boiler settings.
10. Leaky baffles.
11. Soot in the tubes.
12. Scale in the tubes.
13. Safety valves blowing.
14. Leaky blow-off valves.
15. Steam leaks of any kind.
16. Stokers or grates out of repair.
17. Bare steam pipes.
18. Dirty feed water heater.
19. Low feed water temperature.
20. By letting some boilers loaf when they should do their part.

The above discussion on the matter of saving coal is a very brief outline on the most important things pertaining to the boiler room. I hope in the next article to discuss the operation of engines, generators, switchboards and transformers to obtain increased economy.

Seven Suggestions on the Management of Boilers

Assuming a properly installed and equipped plant, the attendant should be a sober, industrious man with enough intelligence to realize the responsibility of his position; he should be well paid and should give heed to the following, writes Mr. L. R. Hoffman in Power:

1. Boilers should be kept free from scale, sludge and soot, inside and outside; frequency of cleaning depends on conditions, but they must be clean at any cost.

2. At least one gage of water should be blown out of a boiler daily, and more as conditions demand.

3. Pop valves should be lifted from their seats at least once a day, and they should be kept clean and free inside and out.

4. Water columns should be blown out at least once a day, noting that the water returns quickly and does not stand dead still; the water should rise and fall gently in the glass at all times.

5. Try-cocks should be blown at least once a day and kept free and clean.

6. If only one boiler is in use, two steam gages should show the pressure, and when they do not agree they should be inspected and adjusted at once.

7. Sudden contraction and expansion of the metal of a boiler saps its strength. This should be avoided by keeping the feed water going into the boiler steadily, holding the water level near the same place when this is possible.

Removal of Oil in Exhaust Steam.—Where oil in the exhaust steam is liable to give trouble, a large proportion may be removed by means of an efficient oil separator, but it is extremely difficult to remove oil from condensed steam and great care must be taken to see that there is no appreciable amount of oil in condensate used for boiler feeding, otherwise serious damage to the boilers from local overheating will result from the deposit of a non-conducting film of oil on the heating surface.

How Fuel Can Be Saved in the Power Plant*

Steam Traps.—Hundreds of cases come under observation where steam traps are either leaking or are bypassed and where the leakage is a source of direct waste. The discharge from traps is frequently connected directly to the sewer or to mill trenches where leakage is invisible, and waste may go on for months and even years undetected. This subject of leaky traps is a long story, but therein lies a great possibility. Nearly every steam plant has steam traps, and sometimes there are hundreds of steam traps in a single manufactory. Yet it is probable that not one plant in ten has its traps so equipped and connected that they can be readily tested for leakage. It is the opinion of a number of engineers that of all the steam traps in Rhode Island today, probably over 75 per cent are either leaking, are bypassed or are in some way failing to serve their purpose purely for want of regular supervision.

Blowoff Valves.—Probably not one steam boiler out of a hundred in Rhode Island has the boiler blowoff valves so arranged that they may be readily tested for leaks. Moreover, it is fashionable to submerge the end of the blowoff pipe in some river or brook so that no offensive steam cloud caused by leakage will be perceptible. The blowoff platitude would be as follows:

Are the blowoff valves so connected that they may be readily tested every day?

Pipe Covering -Pipe covering is almost an axiom of steam economy, yet there is no systematic periodic inspection and recorded report on the condition of this most thrifty means of saving coal. It is a popular custom not to cover the flanges because of the inconvenience when a joint leaks.

Excessive Back Pressure on Engines—Where steam is used for heating and drying purposes, it is often economical to operate engines and other prime movers against back pressures. Under these conditions every effort should be made to have this back pressure as low as possible. In one instance, where a single back-pressure gage was in use, it was stated that 1 lb. back pressure was all that was required. But the gage in use and which indicated a pressure of 1 lb. was found to be nearly 4 lb. in error due to faulty piping, and the back pressure was in consequence nearly 5 lb. The platitude in this case would be:

Test the pressures periodically.

In many cases the back pressure has been reduced owing to a more efficient circulation of steam by vacuum heating systems or other means. Plants running condensing can frequently obtain a better vacuum by eliminating air leaks, etc. It is not unusual to find a poor vacuum caused by insufficient condensing water which latter is caused by obstructions in the piping such as leaves and accumulations of foreign matter.

At least four cases have been observed by one engineer where live steam was blowing directly to the atmosphere in large quantities through the low-pressure steam system. These were in the case of a supposedly insufficient supply of exhaust steam, where live steam was being admitted to make up the supposed deficiency. At the time the live steam was being admitted through a reducing-pressure valve or by hand control, the back-pressure valve was partly open, allowing the escape of steam direct to the atmosphere. The remedy is to install properly sensitive back-pressure and reducing-pressure valves so arranged and set as to pressures that it will be impossible for such waste to occur.

Wasteful Vacuum Systems Some of the older vacuum heating systems are wasteful in that considerable quantities of water are required at the vacuum pump to assist in maintaining a vacuum. This condition is frequently caused by improper automatic expansion valves on the return ends of radiators, in many cases it having been found that the interiors of the valves have been entirely removed, allowing the steam to be pulled through into the return line. Several cases have been observed where large quantities of water were being injected into the vacuum pump and delivered by the pump to an open heater or receiver, and from there overflowing (in the form of hot water) to the sewer.

Leaks—Leaks in pipe joints and flanges are a source of

[illegible]

[illegible] The cumulative [illegible] perhaps a mile a min- [illegible]

Most plants keep their piping systems fairly tight where [illegible] leaks. [illegible] on hidden [illegible] live and exhaust [illegible]. It has been found [illegible] connections, to go through the plant late at night when everything is quiet (both out of doors and inside), at which time it is easier to [illegible] steam.

Large plants should be equipped with valve reseating [illegible] necessary to maintain all steam valves in proper condition. This is another matter that should have systematic attention.

Heating of Water.—[illegible] common in plants using large quantities of hot water to find this water being heated by live steam, while at the same time exhaust steam is being wasted to the atmosphere. This matter needs little comment as it is obvious that great economies can be effected by using exhaust steam for this purpose.

What War Has Taught Boiler Plant Managers

The lessons learned by boiler plant managers from the operations under war conditions were summarized as follows by Mr. Edward Marshall in an address at a recent meeting of a committee of the Ohio Electric Light Association:

Methods of handling boiler-room equipment have advanced.

Boilers have been tested and stokers have been reconstructed that maximum efficiency might be obtained.

Baffles have been redesigned to get a minimum of draft-loss consistent with good distribution of gases.

Arches have been raised and lengthened to give better combustion.

Settings have been rebulit to exclude air, and car loads of setting insulation have been used with wonderful results.

Pipes, feed-water heaters, boiler drumheads, pumps and engine cylinders that were never lagged before have been covered.

Boilers and stokers have been tested to find the highest point of efficiency.

Boiler-room instruments, including draft gages, Orsat apparatus, pyrometers and CO_2 recorders, have been purchased.

Soot blowers, tube cleaners, Venturi tubes, water weighers and flow meters have been installed to get energy to the switchboard for the least expenditure of B. t.u.'s.

More attention has been given to operating data.

The old method of frequently blowing down boilers has been discarded in favor of a titration-test method which saves money by reducing the number of blow-downs to two or three a week.

All of these things have brought out lessons that should not be wasted now that the war is over.

Practical Man with Proper Training Makes Good Combustion Expert.—A good combustion operator need not be highly technical. Experience has shown that the practical man, with the proper training, is the best man for the job, said J. G. Worker of the Westinghouse Electric & Manufacturing Co. in addressing a meeting of the station operating committee of the Ohio Electric Light Association. Statements have frequently been made that certain ends can be attained in operation and economy by employing experts in certain plants. An analysis of such an organization will show that these experts were at one time in the boiler room firing coal. They were trained in combustion and gradually began to think for themselves along combustion lines until they became analytical and commenced looking around for the things that affect the economy of the plant. The building up of a boiler-room organization for any plant can best be accomplished by taking a good man in the organization and building him up for the job. Very little success will follow a plan of bringing outside men into the organization who have the reputation of being the ultimate authority on combustion work.

Education of Boiler Room Men Necessary for Fuel Conservation

Experiences of several large companies in fuel conservation at their power plants are summarized by Mr. Edgar A. Hunger in an article in the Electrical World. In his article, an abstract of which follows, Mr. Hunger points out the importance of the human element factor in fuel conservation efforts, and outlines means for fostering the interest of firemen.

A study of fuel economy by means of the human element is of particular interest at this time since increased labor turnover and general scarcity of labor have added difficulties in organizing efficient boiler-room forces and in creating a spirit of economy among the men without which real fuel conservation is impossible. In many cases the shortage of labor supply has forced managers to direct attention for the first time to the education of their firemen and proper boiler-room accounting methods. In many plants this should be a blessing in disguise, for without careful supervision of the man handling the coal pile large leaks are sure to occur.

The time has come for the introduction of Mr. Manager to Mr. Fireman. It is high time that plant managers should know more about the personnel in the firerooms. The fireman is a human being and likes to feel that he too is an important cog in the big machine. If he is made to think so by the big boss, the other bosses will quickly fall in line and treat him with proper respect. Much depends on the attitude of the "higher-ups," therefore, and if they give the right kind of encouragement and sympathy to the firemen and urge them to think fuel economy and practice it to the best of their knowledge, the possibilities of reducing the amount of coal used will be very good.

Means of Encouraging Fuel Economy.—Various devices may be utilized for fostering the interest of the fireman in fuel conservation. Lectures, night classes and conferences with the chief engineer will help immensely. Placards with fuel-economy precepts printed in large letters posted in open places where they can be plainly seen by every one in the boiler room will also keep the big idea of conservation continually in the workman's mind. To prevent a lapse of interest in these placards they should be changed frequently and, if possible, printed in different colors. Such frequent change will automatically tend to revive the man's interest, and the fact that effort is made to change them will show him that interest in fuel economy in the front office is also not on the wane.

This sustenance of interest in fuel economy is important. Like all good industrial movements, it requires continual application. The idea of fuel economy must frequently be dished up to the fireman in new dresses lest his interest wane. An occasional visit by the manager or superintendent will help. Frequent talks and conferences with superiors should be introduced. Recognition for efforts in effecting savings will also encourage the fireman to keep up his interest in the saving of fuel. The plant bulletin or newspaper is another means for keeping interest in fuel economy at a keen point. In fact, every possible effort for making the fireman think everlastingly in terms of fuel economy should be introduced in order that the plant may operate with a minimum consumption of coal.

The United States Fuel Administration has been gathering data on the practice of fuel conservation in some of the power plants. Some of the information obtained on handling the boiler-room force is given herewith.

E. M. Gilbert, chief engineer of the W. S. Barstow Management Association, writes as follows on this subject: "A year ago our coal cost per killowatt-hour in the West Reading power house of the Metropolitan Edison Co. was 3.2 to 3.3 mills. Our coal costs at the present time are running from 2.1 to 2.2 mills. Part of this economy has been due to an added turbine giving increased economy, and part to a change of mechanical stokers; but fully 25 per cent of it has been due to better methods of handling the boiler room.

"We had contemplated the trial of a bonus system, but some experiments carried on at various places led us to abandon this idea. In the first place, we fond that a great many of the firemen were intelligent enough to take advantage of any bonus system which could be applied on the basis of CO_2 measurements. In the plant where this was tried firemen soon ascertained that the man who did not force his boiler too hard but kept a thick fire with the damper partly shut and not too great an air pressure often obtained a better percentage of CO_2 than the fireman who pushed his fire as hard as possible. While this was in very many cases not entirely true, still the idea became fixed in the firemen's minds that this was the way to earn a bonus, and we immediately had trouble in getting the best results from our boilers and because of the contentions between the men that some were carrying all the load and doing all the work while some were doing little if any.

"In other plants we installed steam-flow meters and tried to work the two plans in conjunction, but we feared that the bonus system, from the little we had experimented with it, would cause trouble among the firemen and would disrupt our labor organization, which was difficult enough to maintain under present labor conditions, and we finally, therefore, adopted the following method:

"We installed two young power-house engineers, boys from college getting from $60 to $90 per month, who were anxious to progress and interested in our work. CO_2 recording apparatus, which could be transferred from one boiler to the other, was installed, and as our boilers are all equipped with steam-flow meters, feed-water heaters and Richardson coal scales, we were able to keep daily records for each shift in this way. The actual record of what was done by each one of the three shifts is carefully kept and is published each six weeks, showing just which shift is obtaining the best results regarding the actual coal used per kilowatt output.

Stimulating Rivalry Between Shifts.—"The six-week period is adopted because the men change shifts every two weeks, and this length of time gives each shift of firemen two weeks' service on the day shift, two weeks' service on the night shift and two weeks' service on the graveyard shift. This plan stimulated the rivalry between the shifts to a great extent, and though no bonus or money offer was made to the firemen, a spirit of competition has developed between the shifts, especially between the foremen of each shift, as to who can obtain the best results. The young engineers whom we have employed not only take an analysis of the coal occasionally but analyze the ashes taken out by each one of the shifts each day to determine the amount of carbon contained in these ashes. A sample is taken by the ash men when they are cleaning out the ash pits, and the analysis is made every morning, being published for the benefit of the various shifts. By this method we have reduced the percentage of carbon found in the ashes by more than 50 per cent.

"At the present time a great deal of difficulty in obtaining coal is being encountered, and fuel of any class or description is being used, so that we are not able to make so much progress with our conservation of fuel as we had hoped, the variation in the fuel value being such that the comparison between the shifts is now often useless.

"We think the method described above is one of the best which can be used, and we still hope that we can work out a satisfactory bonus system for each shift as soon as conditions improve regarding coal supply.

"Our men show intelligence, and a great many of them show eagnerness to obtain information regarding the methods of operation. We find that the employment of a high class boiler-room engineer, who knows enough about the apparatus and firing to have the entire respect of the boiler-room force, is essential and has a great deal to do with the proper application of any method which may be put into use."

Present Boiler-Room Labor Needs More Supervision.—Another interesting communication on the same subject, from E. J. Billings, mechanical engineer for Henry L. Doherty & Co., is given below:

Just at the present time, and for several months past, we have found it necessary to devote a large part of our energies to a study of our plant organizations in an effort to keep them up to their standard of a year ago. We find that under the present labor conditions it is necessary to provide considerably more plant supervision than heretofore. This is due, of course, to the shifting and uneasiness of both skilled and unskilled labor.

"The demand for a few unusually keen operating men in the more important positions of every plant has never been felt by us so greatly as at the present time, and we believe that we will be fully compensated if we devote our efforts to finding and developing men of this class.

"Some other things along the line of fuel saving which we are doing may be mentioned very briefly. We have our plant inspectors who visit our plants at intervals and report in detail on the physical condition of the plant equipment. We also have results engineers who study and analyze the operating results, make plant tests, etc. We have a chemical laboratory for analyzing coal, ashes, oils, water and other power-plant material. We have recently been sending out a series of fuel-saving bulletins to be posted in our plants, one at a time, calling attention to some of the elementary principles of boiler-plant operation.

"We are equipping our plants as rapidly as possible with steam-flow meters on each boiler and meters for measuring the feed water. We are also giving a good deal of attention to keeping our boiler setting air-tight by the use of boiler coatings or cements which are now to be found on the market. We are also equipping our boilers as rapidly as possible with mechanical soot blowers to take the place of the old method of using a hand steam lance.

"We have tried various plant bonus schemes with more or less success, and while we are heartily in favor of the plan, we have been unable as yet to apply it generally throughout our plants, or with continued success in any one plant, owing to changes in plant conditions, to shifting labor conditions or to defects of the plan."

Dealing with the Personal Element.—The following from Samuel Insull, president of the Commonwealth Edison Co., tells how the personal element is handled in the stations of the great Chicago electric company to bring about fuel economies:

"Technical, experienced men, who are in charge of the boiler-room tests which are frequently conducted, instruct and educate the boiler-room operating men in the more important positions in the importance of proper methods of firing and operating the boiler-room equipment and the effect that the proper methods have upon the actual resulting efficiency in the production of steam.

"The two things that they are taught to avoid are the running of too thin a fire and thus admitting an excess amount of air and, on the other hand, running too thick a fire and thus losing too much coal over the end of the grate with the ashes. Of course, with the chain-grate stokers generally used in this part of the country, in order not to have too thin a fire as the grate travels toward the back end of the furnace, a certain amount of coal, perhaps 1 or 2 per cent, with good firing, is allowed to go over the grate with the ashes; but the point is to run the fire so that not more than the necessary amount of coal is allowed to go to waste with the ashes. For best results, the fire must run as strong or as hot as possible, and the firemen are required to cut off boilers as the load decreases, rather than continue to operate all the boilers with less intense fires.

"In smaller plants, in cases where the grate area is a little larger than is necessary for the demand for steam, rather than reduce the intensity of the fire, it is our practice to reduce the grate area."

Cleanliness about the boiler room is an important factor in the maintenance of economical use of fuel. The boiler, for example, never can be too clean, both inside and outside. Soot is a poorer conductor of heat than asbestos. It pays, therefore, to clean the flues frequently. Similarly, if the interior of the boiler is coated with scale, much more coal is required. These two items, the cleaning of tubes and removal of boiler scale, are especially liable to neglect and a continual check is absolutely necessary.

Talks on fuel economy in industrial and power plants are nothing new. The United States Bureau of Mines has been preaching it for years. In fact, some of the best books in circulation on fuel conservative have been prepared by the bureau. These books are easily available on the payment of a nominal fee, and it might be well to circulate them among the boiler-room men.

Fuel Economy Precepts.—The following oft-repeated fuel-economy precepts for hand firing with soft coal may be worthy of one more repetition. Technical Paper No. 80, on "Hand Firing Soft Coal Under Power Plant Boilers," published by the Bureau of Mines, Department of the Interior, contains a wealth of material on the same subject:*

1. Fire small quantities at a time at short intervals.
2. Keep the fuel bed even by placing the coal on the thin

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*The Fuel Administration has a limited number of [illegible] for free distribution. Apply to the Fuel Engineer [illegible] Bureau of Conservation, Fuel Administration, Washington [illegible]

[illegible] and [illegible] the fac[illegible]

1. [illegible]

2. [illegible] by [illegible] the draft, [illegible] in the uptake [illegible] the fire is banked

3. [illegible] steam is small and while cleaning have the draft damper partly closed.

4. [illegible]

In [illegible] must be made on the man in the boiler room and the man behind the shovel. Strict records on the amount of coal used and steam produced from this coal should be kept. The men in the boiler [illegible] that their jobs are important and not for the fly-by-night individual. Shorter hours, better pay and better working conditions—in a word, just [illegible] are getting will help [illegible] their jobs and stay at them, [illegible] and become skilled workers who will save many times the actual cost of in[illegible] the saving of many [illegible]

Trenching Machine for Digging in Close Quarters

A side-wheel excavator that can dig close to curbing, lines of poles, abutting walls and in other close quarters where [illegible] to the line of the Pawling & Harnischfeger Co., Milwaukee, Wis. The ditcher with standard side clearance cutters is designed to dig a trench 15 in. wide to a maximum depth of 4 ft. Side clearance cutters can be furnished to enable the machine to dig to a maximum width of 24 in. The digging wheel, mounted at the side of the machine, as shown in the illustration, is of the open type without axle. It is driven from the jackshaft by means of two chain reductions, the intermediate shaft being mounted on the wheel frame. The machine is driven by a 25-H.P. 4-cylinder vertical engine of the traction type arranged for burning either kerosene, gasoline or other motor spirits. The general dimensions of the machine are: Width over all, 10 ft. 7 in.; length of car body, 18 ft.; length over all, 25 ft. 9 in.; height over all, 9 ft. 7½ in. The weight on the "corduroy grip" tractions is 19,500 lb.

Side-Wheel P & H Excavator.

Personals

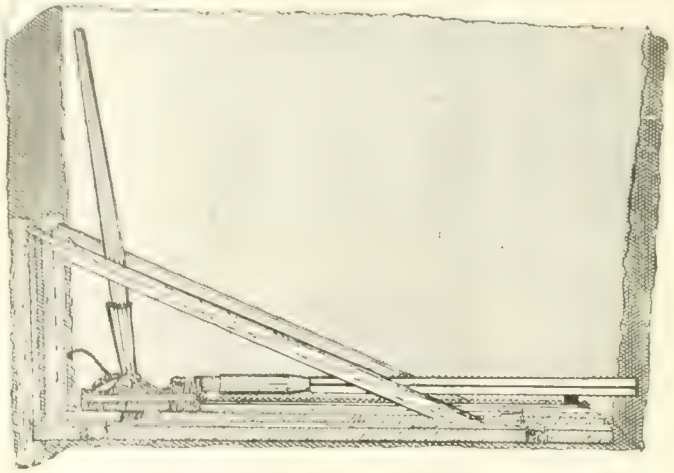
[illegible] West [illegible] Rensselaer, N. Y.

Richard H. [illegible] has been appointed director of the street and [illegible] of Wilmington, Del.

J. A. Elliott, of Wheatland, Wyo., and C. W. Atherly, Basin, Wyo., have been appointed members of the Wyoming State Board of [illegible] Examiners.

Pipe-Placing Machine That Eliminates Opening Paved Streets

A pipe-placing machine that does away with the necessity of opening up pavements for laying water or gas service lines has been developed by the McNutt Meter Box Co., Box E 3, Brazil, Ind. The machine operates from a trench about 60 ins. long by 14 ins. wide, at any desired depth. A system of three sighting stakes enables the operator to push the pilot and joints to any point across a street, under car tracks or railroads. The only other digging required is a small trench at the service box, where the machine pulls the pipe into the hole driven by the jack. With this machine, it is claimed to be possible to run pipe even under buildings. In tests up to a distance of 47 ft., the variation from dead center of aim at the point to be reached was never more than 4 ins., and the manufacturer estimates an efficient range of 75 ft. at one setting of the machine. The machine will place either iron or lead pipe in size from 4-in. diameter down to the smallest working sizes.



McNutt Pipe Placing Machine.

Statement of the Ownership, Management, Circulation, Etc., Required by the Act of Congress of August 24, 1912,

of Engineering and Contracting, published every Wednesday at Chicago, Ill., for April 1, 1919.

State of Illinois, County of Cook, ss. Before me, a notary public in and for the state and county aforesaid, personally appeared H. P. Gillette, who, having been duly sworn according to law, deposes and says that he is the editor of Engineering and Contracting and that the following is, to the best of his knowledge and belief, a true statement of the ownership, managment (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to-wit:

1. That the names and addresses of the publisher, editor, managing editor and business manager are:

Publisher—Engineering and Contracting Publishing Co., Chicago, Ill.
Editor—H. P. Gillette, Chicago, Ill.
Managing Editor—C. T. Murray, Chicago, Ill.
Business Manager—Lewis S. Louer, Chicago, Ill.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.)—H. P. Gillette, Chicago, Ill.; Lewis S. Louer, Chicago, Ill.; N. M. Rodgers, Chicago, Ill.

3. That the known bondholders, mortgagees and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages or other securities are: (If there are none, so state.)—None.

4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security hoiders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association or corporation has any interest direct or indirect in the said stock, bonds or other securities than as so stated by him.

H. P. GILLETTE.

Sworn to and subscribed before me this 28th day of March, 1919.
(Seal.) C. E. MEINDERS.
(My commission expires June 20, 1920.)

Railways and Excavation Monthly Issue

ENGINEERING AND CONTRACTING

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HALBERT P. GILLETTE, *President and Editor* LEWIS S. LOUER, *Vice-President and General Manager*
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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The *articles* in the first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering and contracting field. The *articles* in the first and last issues of each month (1st and 4th Wednesdays) completely cover county engineering and highway engineering and contracting. The *articles* in the third and last issues of each month (3rd and 4th Wednesdays) completely cover steam and electric railway location, design and construction. See the "mast head" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power

Railways and Excavation—3rd Wednesday
(a) Excavation and Dredging
(b) Rivers and Canals
(c) Quarries and Pits
(d) Railway Construction—Steam and Electric

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbors Structures
(d) Miscellaneous Structures

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How High Wages Can Be Held and Prices Lowered

The average wage of all employes of railways is now $1,460 a year, or an increase of 80 per cent over the average paid in 1914, and 117 per cent over the average of 1910. The average wage now paid by the U. S. Steel Co. is $1,950, or 124 per cent greater than the average for 1914. The average wage of members of train crews is now $2,020, as compared with $1,253 in 1914.

These statistics should be very significant to civil engineers, in many ways. Have the salaries of civil engineers increased proportionately? If not, why not? Can it be expected that construction and material prices will recede in the face of 50 to 125 per cent increases in rates of wages?

Some political economists predict a "permanently higher level" of prices in America. Others predict a rather rapid lowering of the price level. But nearly all are agreed that rates of wages will not recede until prices have fallen. Our own opinion is that rates of wages will rise rather than fall. We base this belief partly on the fact that workmen, both organized and unorganized, are determined not only to hold what they have but to get a larger income. Our other reason for this belief is our confidence in the ability of engineers and managers to secure increasingly larger outputs per man-day.

American employes demand a larger income. Their demand is the despair of many employers, whereas that very demand should be regarded as a welcome sign of growing ambition. Where many men seek to accomplish a reasonable purpose, leaders always are found to show them the way. It is only where ambition is dead or dormant that would-be leaders are powerless. Asia and India are extreme examples that are the despair of those who would emancipate them from wretchedness. America, at the other extreme, should be the delight of every man who has the welfare of his fellows at heart. Here we have an ambitious people, eager to be shown how to better their condition. The great problem now is to devise workable plans for stimulating the average productivity of our workers.

Far sighted engineers are calling upon all engineers to seize the leadership in the coming crusade for greater income and greater leisure. Engineers have designed the productive machinery and they have been latterly redesigning the methods of managing men so as to increase productivity. Engineers stand naturally between the employer and the employe, seeking the welfare of both. Perhaps this can be said of no other class. At

28 Pages = 40 pages

The 28 pages of articles in Engineering and Contracting contain as many words as 40 pages of the size and typography commonly used by other engineering periodicals. Ours is the same size of type and type-page as that of The Literary Digest—easily read, yet giving a large volume of reading matter per page. Our 28 pages of articles would fill 112 pages of the standard 6x9 in. text-book. It would take 10 such books of 580 pages each to hold all the articles printed each year in Engineering and Contracting, to say nothing of our weekly construction news.

[illegible] idealism con-[illegible] knowledge of how to secure results.

[illegible] are usually [illegible], but they are apt to lack [illegible] the economic training and the sense of practicality that is possessed by engineers. Socialists are idealists. Engineers are idealists also. The goal is the knowledge of how [illegible] results [illegible] and tomorrow. The pure idealist [illegible] of time. His visions may be definite enough [illegible], he can not tell how long it will take to realize them. The engineer, always dealing with the affairs of [illegible] and of the definite future, has learned to regard time as one of the essential factors of every economic problem. He can not be vague as to when a desired end shall be attained. His is the function to be definite in [illegible].

If engineers will now assert their right to be leaders of the public, they will speedily displace pure idealists as leaders, for there is a general craving for idealism plus practicality. The public is not tired of dreams and dreamers; it welcomes both. But, unless we misunderstand this practical American public, it prefers dreamers who are not only the heralds but the creators of fast-following realities. Such dreamers are the engineers.

Why Illinois Shows Wisdom in Not Waiting for Road Material Prices to Decline

[illegible] of Chicago have been saying that the Governor of Illinois has been opposed to starting state road construction on a large scale until lower prices of materials could be secured. Apparently this opposition has come to [illegible] bids on state road contracts totaling 100 miles of roads are to be opened April 24.

We take it that the Governor and other state officials have come to the conclusion that it is preferable to provide jobs for idle men than to wait for problematical reductions in the prices of materials. This is a wise decision, for it will certainly be cheaper for the citizens to pay a little more for road materials than they want to pay, than to stand the vastly greater expense of supporting an army of idle [illegible]. A [illegible] official is prone to forget that he should shape his economic policy in a much broader way than it would be shaped were he acting as an individual. As an individual the Governor of Illinois might find it profitable to haggle for weeks over the prices of construction materials, for he would not be footing the bill of wages lost by unemployed men during the haggling period. But as an employe of all the people of Illinois the Governor can not ignore the wages that are being lost by many of the people whom he represents.

On the credit side of the public ledger the Governor would like to place a reduction in prices of road materials. But he sees that if it is going to take very long to secure this result he will be faced with a far greater charge on the debit side of the public ledger, namely, the wages lost by idle workers. It is this broad view of the economic problem that has doubtless led Governor Lowden to postpone no longer the letting of state highway contracts. We congratulate him upon coming to this decision, for the road building season is almost upon us. Contractors need a few weeks time to assemble their plant and and to secure new equipment. This preparatory work can not be compassed in a [illegible]. It is a matter of three to six weeks usually, and often longer.

Those that are best acquainted with the reasons for present high prices of road materials are the least hopeful of seeing a substantial reduction this year. In the case of sand, gravel and broken stone, the prices depend mainly on the rates of wages. Wages have almost doubled in five years, and there is small prospect of a decrease this year or next.

In another editorial we have commented upon the 80 per cent increase in the average wages of railway employes and the 124 per cent increase in the average wages of the U. S. Steel Co. employes. Manufacturers of road materials have had to grant similar increases. How absurd, then, is it to contrast present prices of road materials with those that existed prior to the war, and argue from such a contrast that a marked reduction in material prices should occur at once or in the near future.

In the case of the metals, like copper and steel, where overhead costs are very great and where large stocks of metal have been accumulated, a somewhat different economic condition exists. Copper has dropped 40 per cent, and steel has been reduced about 15 per cent in price. But in the case of road materials there is neither a large stock on hand, nor is the overhead cost so great a percentage of the total cost of production. Wages constitute so large a part of the cost that until wages recede, or until more economic methods of production are developed, there can be no very great reduction in road material prices.

It seems to us preferable to accept present rates of wages as "permanent," and to turn our thoughts toward increasing the output of workers so greatly that wages will not recede. In this way we can secure gradually decreasing prices in the face of high wages. Let our eyes be turned toward this goal rather than toward the forcing down of prices by refusing to buy. Forced price reduction is apt to prove a very expensive method of saving money.

Shall the Railway Investor Be Asked to "Hold the Bag"?

Railway rates of wages have advanced 80 per cent in five years. The price of rails has gone up an equal percentage. Coal has almost doubled in price. But, somehow or other, the public hopes to avoid a similar increment in freight and passenger rates. It requires but little study of the problem to see that the only way in which the public can attain its hope is by depriving railway owners of a fair return on their investment.

A few years ago, before the great rise in wages and prices, it was commonly said that a "fair return" on capital invested in railways was 6 to 7 per cent. But if the average price level is to remain, say, 170 per cent above the pre-war level, then $1.70 will buy only what $1 would buy before the war. Consequently a railway stockholder who now gets 6.5 per cent on his pre-war investment, actually is worse off than a stockholder who received only 4 per cent before the war. Putting it differently, a $4 dividend on a share of stock prior to the war would buy as much food, clothes and shelter as 1.7 times $4, or $6.80 will now buy.

If railway and public utility stockholders are not to be made "bag holders," it is evident that they should receive a fair per cent of dividends on the cost of reproducing their property at present prices. This will sound rather startling to those who believe in actual cost of property as the proper base upon which to estimate returns to stockholders. Yet, if equity is to be preserved, there seems to be no escape from the proposition that railway and public utility rates must be based on present costs of reproducing the plants.

Consider what is happening in the real estate field. Rents are steadily rising. Farm real estate has more than doubled in value in six years. Why? Because while the rate of interest used in capitalizing values has remained constant, the net earnings from farm properties have doubled. City real estate also shows a rising tendency, because rents are steadily rising. If the prices of building materials stay up, it is inevitable that all rents will rise; for, if there is a demand for the new buildings at the higher rents that they will command because of their higher cost, the landlords of old buildings will not be very slow in raising their rents.

Similarly the owners of factories will find it possible to maintain a high enough price for their products to yield at least a normal interest on the cost of reproducing their plants new at present prices of materials.

In short, the owners of every class of property except railways and public utilities, will be free to raise the prices of their products until they secure at least a normal interest on the cost of duplicating their property at the existing level of prices of materials and rates of wages. All this follows from the law of supply and demand. The rates charged by railways are subject to public control. Shall this control be so exercised as to compel railway stock owners to accept a fixed percentage of return on a fixed value of property when all other values have risen 70 per cent? If this question is answered in the affirmative by the public, then Government ownership will soon follow, for new capital will cease to flow into so unpromising a pool.

The same will happen as to every class of public utility. Already the street railways of the country are dangerously near bankruptcy, because rates of fare are insufficient.

Even should rates be raised so as to yield, say, 6 or 7 per cent on the invested capital, investors in public utilities would remain disinclined to make further investments until assured that the base for future rates would be the future cost of reproduction of the plant. Since the prospect of securing a "fair deal" of this sort is remote, we are inclined to think that city ownership of street railways and other public utilities is imminent. Government ownership of railways will inevitably follow, unless a much more liberal attitude toward investors in railway securities is soon adopted.

For 10 years the managers and owners of railways and public utilities have struggled to secure more liberal treatment. They might have continued the struggle another 10 years had not the war suddenly caused a crisis by nearly doubling wages and prices. As it now stands, these men are about ready to quit. They are tired of continuously fighting. They are sick of continuous criticism. They know that it will be a great economic blunder if the public buys the railways and public utilities. But they are fast becoming resigned to seeing the blunder committed. Perhaps they feel toward the public as the rest of the world feels toward the Russians. If ignorance can not be persuaded by wisdom, then let it be persuaded by its own bitter experience.

Who Are the "Workers?"

Under this caption The Manufacturers' Record recently took President Wilson to task for saying: "I am as keenly aware, as anybody can be, that the social structure rests upon the great working classes of the world." Although the Record" stated nothing new when it contended that brain workers are as essential as manual workers in sustaining the "social structure of the world," it was well to give emphasis to this fact at this time.

In the actual presence of men who have achieved great things by the power of the mind—men such as Edison or Burbank—there are very few "workers" of any class who will not gaze with an admiration akin to awe. But it is unfortunately a fact that manual workers seldom see the greatest of brain workers, and still more seldom hear their achievements explained and extolled. Labor agitators are given to painting all brain workers as mere exploiters of labor. They avoid picturing what this world would be had it not been for brain workers. Never do they throw upon the screen pictures of the toiling, ill fed masses of India or China—the masses whom no brain workers have ever seriously "exploited," the masses with few public utility plants and railways, the masses unfreed from drudgery by the power of brain workers, the masses still slaves to manual precedents and almost unaided by the things that brains have invented, developed and put into effective use.

Measured by productivity due to his personal efforts, Luther Burbank has done more work than all the farmer hands in Kansas, for he has more than doubled the productivity of scores of plants. Would it not be wise to tell the manual workers of America about such men as Burbank, about the great inventors, engineers and industrial captains who have so enormously increased the income of the average American worker?

Our schools have taught political history, and it has been of little practical use to the average man. Had industrial history and the biographies of its real makers been taught, we should be today in less danger of bolshevism of any kind

New Listening Instrument May Be Used in Tunnel Work.—The geophone, a listening instrument invented by the French during the war to detect enemy sapping and underground mining operations and for the location of enemy artillery, is now being used by the Bureau of Mines, Department of the Interior, as a possible aid in locating miners who have men entombed after a disaster. The instrument was developed by United States engineers during the war and is now used by the bureau according to plans drawn by these engineers. Now that the war is over the bureau work has turned to the development of the instruments for peace time uses. In metal mines expensive surveys have sometimes to be made in order that approaching tunnel headings may be brought accurately together. Since direction can be determined so well with the geophones, it is thought that they can be used to guide such work.

Freight Rates on Road Building Materials

To the Editor: Referring to the last paragraph of the editorial in "Engineering and Contracting" of Feb. 19, 1919, entitled: "The Paramount Duty of Engineering Societies in the Present Emergency."

I assume you are well aware that present freight rates do not meet the cost of maintaining and operating the railroads, to say nothing of a return on the investment. That being so, either there must be some increase of freight rates or the taxpayers must make up the deficiency. That being the case, do you not think the engineers and engineering societies were wise not to be represented at the important conference you refer to? Perhaps that is what you had in mind, although I do not think you have made it very clear.

Freight rates on sand, gravel, stone, etc., have been disproportionately low. Perhaps it is your thought that it would be better to let the rates on these commodities remain, and increase those on other commodities so as to put railroad operation on a self-paying basis; but if a self-paying basis is desirable for the railroad, why not apply the same principle to the rates for sand, gravel and stone?

C. F. LOWETH,
Chief Engineer,
Chicago, Milwaukee & St. Paul R. R.
Chicago, Ill.

[There is no doubt whatever that the general level of freight rates is too low, in spite of the recent increase in rates. But it is our opinion that the rates on sand, stone, etc., for road building should not be raised again for some time to come. Freight rates are usually so designed as to yield the maximum percentage of net earnings on the invested capital. Since a substantial increment in farm produce shipped by rail will aid in effecting this purpose, it will be good railway policy to keep down the rates on road building materials; for the greater the mileage of good roads the larger will be the tonnage of farm produce shipped by rail. Moreover—and this is even more important—the "peak load" on the railway plant will be lowered by the building of a more extensive mileage of hard roads. This follows from the fact that hauling of farm produce to railway stations is not confined to good weather periods, but occurs more uniformly where roads are usable every day of the year. Finally, it is good public policy at the present time to employ as many men as possible in road building. Every dollar of decreased freight cost on road materials makes available a large part of a dollar for wages of road builders.—Editors.]

Book Reviews

Cost Accounting. By J. Lee Nicholson and John F. D. Rohrbach. Published by The Ronald Press Co., New York. Price [illegible]

This book of 576 pages is written by two well known accountants. It is intended primarily for factory accounting, but there are some parts applicable to construction accounting.

With the exception of the chapter on Depreciation and Maintenance, the book has been well written. That chapter relates to a very important subject, yet it is lamentably weak. We suggest to the authors the wisdom of carefully studying the writings of engineers on this subject. The 62-page chapter on Depreciation in the Handbook of Mechanical and Electrical Cost Data by Gillette and Dana offers a strong contrast to the 19-page chapter in this book, both in method and in completeness of treatment.

The most valuable part of the book to civil engineers and contractors is the part relating to "Cost-Plus Contracts," which covers about 60 pages. This part may alone be worth the price of the book to anyone who is drafting a cost-plus contract.

Modern Management Applied to Construction. By [illegible]. Published by McGraw-Hill Book Co., New York. [illegible]

This is a 200-page book whose title well indicates its scope. The titles of the 10 chapters are as follows:

I. What is Scientific Management? II. Old Versus New Management. III. Principles of Modern Management. IV. Finances and Efficiency. V. Fundamentals in Choosing Type and Amount of Plant. VI. The Application of Motion and Time Studies. VII. Application of Modern Management. VIII.

[illegible] IX. [illegible] Construction. [illegible] Upon Workmen [illegible] War Construction Forces.

The [illegible] experience as a contractor, [illegible] very practical and instructive manner.

The 1919 Edition of Trautwine's C. E. Pocketbook

[illegible] reference book con[illegible] entirely new. About [illegible] to railways. Examina[illegible] the same painstaking authorship that has characterized "Trautwine" from the first edi[illegible].

The [illegible] publisher is the Trautwine [illegible] St., Philadelphia.

Car Wheel Coning and Rail Canting

The coning of car wheels is for the purpose of reducing the shock of unyielding impact when the car sways from side to [illegible] friction between [illegible] on wheel flange and tread and on rail head. The desirability of changing the taper of coning has recently received the attention of the track committee of the American Railway Engineering Association, and in its report to the recent annual convention some interesting facts are brought out relating to present practice.

Prior to 1878 the wheel coning varied. At that time a ratio of 1 in 38 was adopted by the Master Car Builders' Association and this remained standard until 1907 when the association revised the taper to 1 in 20, which is the present standard, excepting on a very few roads which use the 1 in 38 taper.

In the past it has been the general practice of the railroads to place the vertical axis of the rail perpendicular to the plane of the track. However, some roads have deviated from this practice, and canted the rail inward. With the standard Master Car Builders' wheel taper of 1 in 20 and the vertical axis of rail at right angles to the plane of track, the point of contact with the rail of A. R. A. section and 14-in. top radius is 45/64 in. inside of center of rail toward gage side and for wheels having 1 in 38 taper and the same section of rail, the point of contact is 23/64 in. inside of center of rail.

It would appear that the amount of taper for minimum wear of wheel is not the condition which results in economical wear and least stress in rail. In view of the fact that rail must be designed for the heaviest wheel loads, while the wheels are designed for a definite car capacity, it may be expedient to sacrifice some degree of service of wheel to favor the factor of safety and life of rail.

Twenty-eight railroads, including four in Canada, reported to the track committee that they had canted tie plates, for the most part in general use. The slope of the canted tie plate in use, however, reported on by the various roads, varies from 1 in 20 to 1 in 174 with the mileage as shown in table:

[illegible] MILES OF TRACK OF EACH TAPER OF CANTED TIE PLATES.

[illegible]	[illegible]	Miles single track	With taper of
[illegible]	[illegible]	[illegible]	1 in 83
[illegible]	[illegible]	[illegible]	1 in 86
[illegible]	[illegible]	[illegible]	1 in 96
[illegible]	[illegible]	[illegible]	1 in 174
[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	Miles total	
[illegible]	[illegible]		

On the other hand, eleven railroads, aggregating 50,000 miles of line and including some of the best known companies, reported that in their judgment it would not be advisable to cant the rail inward.

The Track Committee frankly admits that it has not received enough information to recommend whether or not the rail should be canted inward and to what exent. It does feel, however, that the canting of rail 1 in 20, which is the same as the taper or coning of the wheel tread made standard by the Master Car Builders' Association, is too much.

In view of the great economic importance of rail wear and wheel wear, it is to be hoped that further investigations will be made which will determine beyond question the proper relations between wheel and rail.

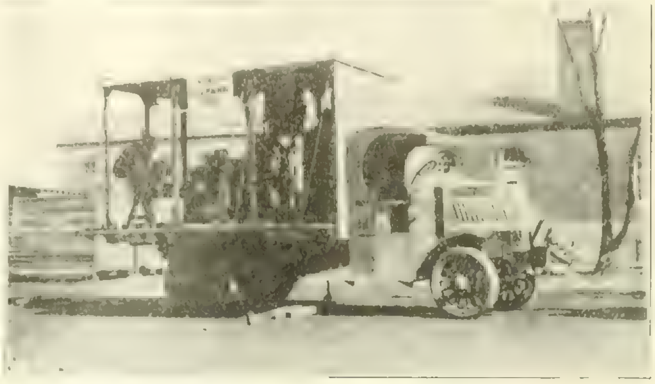
Portable Shops for Repair of Construction Equipment

Early in 1917, the advisability of supplying engineer troops in France with portable shops was considered by the Engineer Department of the U. S. Army. Designs were soon drawn up and orders placed.

The units decided upon form a train, consisting of a portable machine shop, carpenter shop, blacksmith and tin shop, and a portable supply or material unit. Each consists of a special body, mounted upon a 5½-ton truck. The train can be operated as a whole, or each of the units can be operated independently. The shops were designed for the repair of the equipment of practically all classes of engineer troops. This includes equipment for road-making, forestry, quarry operations, pontoon and other bridge activities, water supply, general construction and railroad construction.

The most interesting unit of the four is the machine shop, the equipment of which is outlined below:

A steel body with solid wood floor, supported from proper sills, was arranged to be easily mountable, or demountable, at will, yet secure when under severe running conditions.



U. S. Engineers Field Machine Shop.

The floor spaced body closed is 6 ft. 9 in. by 13 ft. While with the platform sides swung down to floor level, the floor space becomes 11 ft. 3 in. wide by 15 ft. 3 in. long. The head room is approximately 7 ft.

Suitable canvas covers provide shelter for the top and sides not covered by the folding up of the platform extensions.

Within the shop the equipment is arranged to give fair work room about each tool and bench, and, at the same time, all tools or equipment may be removed for temporary use outside.

The principal tools are a 14-in. Le Blond lathe with 5 ft. bed, driven by a 2 h.p. 110 volt motor, the lathe having the usual complement of attachments and controls, an 18-in. drill press, motor driven and capable of drilling with a ⅝-in. drill in steel; a 2-wheel 10 in. by 1 in. 2,000 r.p.m. motor driven grinder; a work bench with vise and 6 drawers, the top made of 1¾ in. oak, being 2 ft. 3 in. by 55 ft. 6 in. long; an electric portable drill, good for 1-in. holes in steel; 2 electric portable hammers, 2 complete oxyacetylene welding and cutting outfits; a reasonable complement of bench and hand tools, abrasives, drills, supplies, jacks, measuring tools, these later being arranged for with proper fastenings in place.

The shop is electric lighted, the wiring being carried in regulation conduit, and with suitable outlets for cutting in or out, to or from the engines, tools or other units outside of the shop.

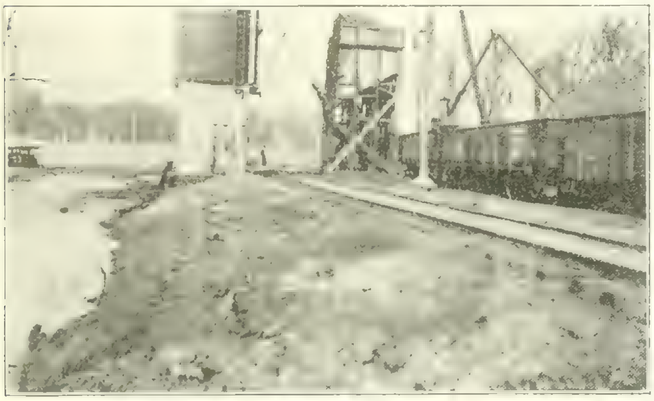
A suitable corner crane with a 1,000-lb. Pale triplex hoist serves the purpose of lifting heavy articles onto or off of the floor and ground. The power plant is an independent unit, direct connected, 4 cylinder, 1,000 r.p.m. Winton gasoline engine, and 5 kw. generator complete with switchboard, tanks and cooling system, arranged for power and lighting circuits.

The cost of the complete outfit—truck, body, and complements of tools at war prices was less than $8,500. The entire train complete cost $27,800. The body and tools weigh around 11,000 lb. A number of the complete trains were used in France and others on this side at the training camps and schools for engineer troops, giving excellent satisfaction and receiving favorable comment from those who used them extensively.

It is believed that the outfit should have a place in the equipment of any contractor who handles projects of reasonable size. The investment is not large, and the service capable of being rendered on the spot, in quick order, would save much time of delivery of parts for repairs usually sent to a village shop. The body could be demounted at the site and the truck used for other work in the interval. Interest on the investment added to a 12 per cent depreciation amounts to about $1,200, which, for 300 working days, makes a cost of $4.00 per day added to supplies needed. On this basis, it is not hard to figure the volume of yearly business which would warrant the maintenance of such an outfit.

Storage Bin and Loading Chute for Coaling Contractor's Equipment

When grading for the Markham Yard of the Illinois Central R. R., near Chicago, was started in July, 1918, due to the war conditions, the question of getting sufficient coal and the prompt unloading of cars were important problems to be considered. It was estimated the contractors would require for the work, from 7 to 9 cars of coal per week. In order to handle this amount without serious delay (frequently one week's supply would be delivered at one time), it was decided provision would have to be made for ample storage, as well as for prompt unloading of the cars.



Coal Unloader and Bin at Markham I. C. R. R. Yard.

To satisfactorily handle the problem it was decided to set up a stiff leg derrick with a 60-ft. boom, equipped with a 1½-cu. yd. clam shell bucket for unloading coal. To provide for promptly coaling the engines it was decided to erect adjacent to the running track, a gravity bin with sloping pockets, and three vertical sliding doors, with hinged chutes to coal the engines. This bin was 12 ft. wide and 24 ft. long and of a total height of 30 ft., and an average depth of 14 ft. It had a capacity of two carloads of coal. This was deemed sufficient for the purposes required, as it would enable most of the coal to be unloaded direct from the cars into the bin and save rehandling, and was of large enough capacity to take care of any breakdowns that might occur to the plant. The arrangement of derrick and bin was such, that it would permit the storing within a working radius of the derrick of from 30 to 40 car loads of coal. Frequently there were as many as 25 to 30 carloads in the storage pile. The derrick has a 12-ft. bull wheel for swinging, and is operated by a double drum hoist, and a counter weight drum for handling the bucket line. To operate the derrick, two men are used, one hoist engineer, and one general man, to give signals and clean out the car pockets.

The water tank also was located near the bin, so that the engines could coal up and take water at practically the one stop. This installation has worked out very satisfactorily as there has never been any delay in its operation, and there has been no delay in getting coal to the engines or steam shovels, which latter is handled by taking the required amount of coal in a dump car, from the coaling plant, and dumping on a coal board alongside of the steam shovel.

The Walsh Construction Co. has the contract for the grading, M. W. Woolsey of that company, being in charge of the work. F. G. Walter, Jr., Assistant Engineer Illinois Central R. R., represents the railroad.

General Problems and Aspects of Grade Separation

Track elevation in American cities has been a very live subject for some years. Scarcely a large city has failed to do some work in the separation of highway and railroad grades, and today many cities of moderate size, with the example which has been set them by their larger neighbors, have at least awakened to the benefits to be derived, and to the importance of planning for the future in such a way as to best promote the city's welfare. Each city has its own peculiar problems, depending upon industrial conditions, topography, city layout, and the number and importance of the railroads within its limits.

The Division of Grade Separation and Bridges, of the city of Detroit,, has recently issued a report which is partly a progress report and partly a study of the general and special problems with which the city is confronted as it looks forward to an extensive program of construction. Many of these general problems and aspects of grade separation are necessarily common to other cities, and in the belief that the statement of these may be of interest to engineers engaged in similar preliminary work in other cities, we have quoted freely from this report.

Grade Separation and City Planning.—Grade separation may be considered an important phase of city planning, because in its broadest sense city planning deals with all the activities of life in a great city. The closing of some streets, the opening of some and widening and the straightening of others are sometimes needed as a part of the solution of the grade crossing problem. The establishment of a plan of main avenues of traffic is not only necessary for the convenience of the present population, but it gives better control over the platting of land and the laying out of streets. The general rule seems to have been that American railroads were built with but little thought of the possible dangers and interruptions to traffic due to grade crossings. As traffic density increased upon the railroads, and second, third and fourth tracks were added, certain crossings became points of danger and were eliminated. As villages grew into cities and expanded territorially, the need of maintaining a few streets open to traffic at all times, caused both city and railroad officials to seek for some means of grade operation and a considerable amount of the work of elimination has been done in many cities, but in only a few has there been adopted any general comprehensive plan for the complete elimination of all grade crossings. It would appear from a study of existing structures and records that generally the work has been undertaken rather with a view to eliminating crossings because they were a source of danger to human life, or to secure a greater freedom of railroad operation from interruption by traffic on the highway, than as an essential part of a comprehensive plan for bettering city traffic conditions.

New Elements in Street Traffic.—Every rapidly growing city faces certain conditions which tend to increase the difficulty of handling its local transportation. Detroit perhaps more than any other city in America, is now face to face with this traffic problem in all of its phases.

The need for more street cars, more rapid movement of cars, relief of congestion in the downtown section, and additional lines, as well as the possibility of establishing some form of rapid transit, are all matters of public discussion.

The development of the automobile in the past few years and the tremendous increase in the use of motor driven vehicles has introduced a new element in street traffic. Streets which a few years ago had only a few team movements per day are now traveled by hundreds or thousands of automobiles and teams per day. The increase in number of street movements makes more urgent the abolition of grade crossings, especially when we consider that on many streets there has been a corresponding increase in pedestrian movements.

Interests of Public and Railways in Grade Separation.—No final adoption of any plan can be made until it has been considered from every possible angle. The interests of the city as a whole, and of the railroad, are or should be, so closely interwoven as to be a mutual interest and both parties should bend every energy to the immediate working out of a complete plan and its rapid execution.

It is undoubtedly the fact that in many cases the feeling has prevailed that the railroad and the city were opposing [illegible] in many instances the [illegible] interest has been looked upon as the paramount in [illegible] which should [illegible] the desire on the part of railroad managements to avoid large expenditures of railroad money in [illegible] facilities of tracks and yards.

There are cases of encroaching public rights in the interest of present economy without regard to future traffic conditions. [illegible] to be due rather to a failure to [illegible] the extent and importance of the use of the city's streets than to a deliberate attempt to destroy values. It [illegible] everyone that the great growth of the city of Detroit has been of incalculable financial benefit to the railroads. It is equally true that the city is greatly benefited by the improvement of railroad facilities and the correct location of freight houses, team, tracks, switching and storage yards and industrial connections.

Both city and railroad would be benefited by the complete separation not of a few, but of all the streets. The actual carrying out of such separation is complicated by the fact that many hundreds of industries have located along the railroads, have built warehouses or factories and have sidings or industrial connections. Any plan that is adopted must take into account the three interests, and there must needs be [illegible] concessions to one interest or the other.

Interests That Must Be Considered in Grade Separation Plan.—The public demands an open and safe thoroughfare [illegible] clear head room to permit any usual street or street railway vehicle to pass freely. It must consider the future and not limit, by present day construction, the reasonable future use of the street. The public may very properly protest against going up or down a heavy grade or against narrowing any roadway or against closing any roadway which may in a few years be essential to guard against a congestion. The public has a right to demand not only a safe, but a clean, reasonably noiseless, and sightly structure. In view of the fact that the public uses the crossing on important streets tens or hundreds of times to the railroads' once the public interest may be considered the paramount interest, especially if we remember that the railroad is a public transportation utility and that the only reason for the existence of most of the tracks in a city is the convenience of that same public which uses the streets.

The railroad demands good grades—safe head room; the opportunity to run its through trains at high speed, the right to maintain for the benefit of its patrons all such facilities as stations and team tracks; the right to have ample yard facilities for switching, sorting and storing cars, and to have these yards so located that they will meet the requirements of different parts of the city, and further the right to maintain all necessary track connections to industries.

The owners of industries must have such connections as will permit the receiving and shipping of freight. They must also have full use of the streets, and freedom from interruption to the movement of teams and employes to and from the industry. The fact that hundreds of industries are now in existence, on tracks at the surface level, that they have built and adjusted their business to those tracks, greatly complicate matters, as a change in level of track, or street, or both, is bound in most cases to cause a readjustment or a reconstruction to fit the new conditions.

While all necessary side and spur track facilities should be afforded industries, the railroads and the city should co-operate in preventing unnecessary duplication of such service.

In most cases the existing arrangement at the manufacturing plant can be used without material change, in some cases a readjustment can be had by elevating the industrial spur and loading platform or by an interior rearrangement, and in still others, more especially very small industries, the cost of the construction to meet any condition that can be considered is such as perhaps to compel a removal of the business to some other location. All of these interests have been considered in the plans so far completed

The sooner grades are finally agreed upon for every mile of track in the city, the sooner new improvements and extensions to existing industries can be designed to conform to the plan of separation, thereby saving hundreds of thousands or millions of dollars of reconstruction when the actual work of separation of grades is executed.

Grade Separation Plan Should Consider Future Needs.—In [illegible] a city which has grown as rapidly as Detroit, it is essential that consideration be given to future demands. In this case it may be argued that the streets and railroads being now located the conditions of today fix the problem. This is not true. It is clear that all manufacturing plants of the character and magnitude of the Solvay Co., the Ford plants, Dodge Brothers, Packard, and many other large concerns, which locate in Detroit hereafter, must seek a location well out from the center of the city in order to secure room. Detroit is now adding each year to its population the equivalent of two such cities as Jackson or Kalamazoo. The country road of today, with a traffic of 200 to 300 movements per day over a railroad crossing, may next year be paved with a street railway extension to a new plant, and traffic increased to between 1,000 and 2,000 movements per day. The new industry means new business for the railroad and in most cases many additional switching movements per day are made over the crossing, thus increasing the roadbed use.

Considerable work has been done in Detroit in the way of taking traffic counts on numerous streets, and making estimates as to the future growth of the city. This has been done with the realization that some comprehensive program should be inaugurated in order that the work of grade separation shall not lag too far behind the city's needs.

There are three general methods of separating grades of street and railroad which have been adopted.

1. The railroad track is left as it is and the street is either depressed under the track or elevated full height over the track.

2. The street is left as it is and the railroad depressed or elevated to the extent required.

3. Both railroad and street are changed, and such compromises in grade made as best suit the requirements of the particular case.

Grade Separation by Depression or Elevation of Street.—The advantages and disadvantages of the first method may be summarized as follows:

The advantages, all with the railroad, are (a) undisturbed main track, (b) no change of grades, (c) no changes of yards or industrial connections.

The disadvantages to the city are: (a) enormous property damages, often extending several hundred feet from the railroad and onto side streets which may be involved; (b) serious interference in street depression with the sewers, drains, water pipes and other underground construction; (c) impediment to traffic, due to heavy grades of the streets and the additional rise and fall introduced; (d) injurious effect on the appearance of the street; (e) industries located on the railroad must provide new outlet, as, if the grade change involves the full width of the street,they are cut off from access to the street.

The city of Chicago in first treating the grade separation problem spent several millions of dollars on long and costly viaducts over railroad yards. Finally it was seen that this was futile and a comprehensive plan of track elevation was adopted and is being carried out. This has involved pulling down many of the costly viaducts already constructed. The Chicago Terminal Commission of 1892 says:

"The topography of the city of Chicago is such that the streets and highways in their natural condition are practically level, and in the exercise of the powers conferred and the duties imposed upon the Common Council, they should be preserved in the same condition to public use, unless there are controlling reasons to the contrary."

The same general conditions of topography prevail in Chicago and in Detroit. In definitely putting aside, as impossible and impracticable the plan of complete elevation or depression of streets and leaving the railroads at present grade, Detroit has not only the arguments which have been advanced, but she has the example of Chicago, which adopted the plan and then abandoned it.

In 1908 the city of Toronto petitioned the Canadian Railroad Commission for the elimination of grade crossings along the water front. The railroads in question proposed that the grades be separated by carrying the streets over the tracks by means of viaducts without changing the grades of the tracks. Chief Commissioner Mabee in his opinion, Dec. 30, 1908, says:

"I am free to confess that when I embarked on this inquiry I thought the erection of bridges the proper solution of the problem, but the more it is thought out, keeping steadily in view the [illegible] welfare of a large and rapidly growing city, I am driven to the belief that, if bridges are erected this year, 10 years hence would see them all torn down."

It has been decided that the first method is not the proper one in Detroit and should receive no consideration.

Changing the Railroad for Separating Grades.—From the standpoint of the hundreds of thousands of citizens who pass back and forth every day on the streets in the course of their business, who are interested in the trucking and hauling of goods from point to point in the city, and who may not come into direct contact with the railroads at all in the course of a year's business, the ideal method is to leave the streets on their present level and move the railroad. The advantages of this method are:

(a) That it leaves the street on the best possible grade.

(b) That it practically or wholly eliminates property damages.

(c) That it creates no interference (in track elevation) with sewers, water mains, conduits or other underground construction.

The disadvantages to the railroad are: (a) introduction of additional grade and rise and fall of 20 to 25 ft. at one or both ends of the district; (b) more or less serious interference with industrial connections, in case of small industries sometimes causing removal; (c) necessitates reconstruction of stations and team track yards; (d) may necessitate removal of yards. To the owner of industries there is involved the change of arrangement of plant.

It is the prevailing notion that the cost of changing the grade of the railroad is much in excess of the cost of changing the grade of the street and leaving the railroad at the old level.

This notion is erroneous. It is perfectly clear of course that to elevate a railroad over a single street, or over two or three streets is extremely bad practice regardless of the qustion of cost, it is equally clear that there are many localities where the cost of elevating the railroad would be in excess of the cost of lowering or raising the streets, but in the average level city, such as Detroit, where the change of grade of a mile of track involves the separation of grades of from eight to sixteen streets there is little difference in cost in the case of the lesser number of streets, and where there are many streets per mile the advantage in cost favors changing the railroad. The reasons for this are obvious. The cost in track elevation is largely in the items of grading, masonry or concrete, and carrying traffic during construction. The same three items with the cost of readjustment of street surface and subsurface structures occur where the street is radically changed and the additional element of damages to property is introduced.

Material for a railroad fill is brought in by train. The cost of steam shovel loading, train haul and unloading will average less than half the cost per yard of the removal of the clay soil in Detroit streets, and its wagon haul to dump scows and dumping will cost. The actual quantities of earth to be moved to fill an entire 100 ft. right-of-way to a height of 20 ft. for 5,000 ft. is approximately the same as would be moved in lowering 12 60 ft. streets on an equal length of track.

The masonry involved in walls for the railroad fill is of uniform height and standard section, while the street retaining walls, having approximately 10 per cent more masonry are irregular in height and section and consequently more costly per yard.

The permanent bridges and cost of carrying the railroad traffic during construction are substantially equal in either case, and the cost of carrying street traffic where it must be maintained is less in the case of railroad elevation than in case of street depression.

There remains the question of track reconstruction and readjustment of industrial tracks, which is more than offset by the cost of rebuilding sewers, water mains, pavement, sidewalks and street railway tracks, and the property damages.

Until one goes into this question fully as the grade separation department has done during the past year, it would not appear to be possible that full elevation of the railroad is the cheapest solution, as far as dollars and cents are concerned. Yet while this statement is fairly true for all railroad rights of way 60 to 100 ft. wide crossing 8 or 9 streets per mile, it will not hold true

(a) In cases where there are only a few streets per mile and where the railroads have large yards;

(b) In cases where the elevation of the railroad involves the elevation of a large mileage of connecting industrial spur tracks or extensive rearrangement of many factory buildings.

The foregoing discussion leads to the conclusion that from the standpoint of most ideal conditions for the city the full elevation of the railroad tracks is the proper thing, that cost of construction is not only not against the method but in the city of Detroit this is the cheapest solution, that inasmuch as the main tracks are elevated for their entire length in the city there is no objection to be urged on account of grade, and that the only reasons that would cause local modification of the plan are:

1. The inability of existing manufacturing plants to adjust themselves to an elevation of 18 or 19 ft. which is likely to occur only in exceptional cases.

2. Difficulties of securing proper team tracks.

These conditions require compromise in such districts as are thickly built with industrial plants or yards.

Separation by Changing Grade of both Street and Railroad.—This plan has been adopted in the case of all "Track elevation," so-called, completed or under contract, to date, in Detroit. The tracks have been elevated from 6 to 10 ft. The streets have been lowered from 6 to 14 ft.

The general recommendations for Detroit are as follows:

(a) Nearly complete elevation over important streets.

(b) Compromise elevation at such points as the needs of permanent industries or the consideration of team tracks or other public facilities of the railroads demand.

(c) Moderate elevation or no elevation in such industrial districts as are on one side of through traffic.

Such a program would really mean—

A. Giving prior consideration to the streets on all through thoroughfares.

B. The complete elimination of all railroad main line grade crossings thus permitting free and fast passage of trains within the city area.

C. Maximum concession to the industries wherever such concession does not perpetuate bad conditions in streets which are, or may become, well used thoroughfares.

With regard to types of construction, the following conclusions are presented:

(a) Streets of 50 ft. or less, where the crossing is substantially a right angle, a clear span without posts.

(b) Streets over 50 ft. or streets on a skew, clear span curb to curb, posts clear of the curb lines.

(c) Extremely wide streets or streets on a bad skew angle, four spans may be permitted and the special type of construction adopted to meet the special conditions shall be approved by the city. Wherever possible driveways shall not be less than 30 ft., measured at right angles to the center line of the street.

(d) In no case shall abutments for bridges be built within the limits of the street.

(e) Exceptional cases of short streets or driveways to factories may be given individual treatment.

The majority of cities have favored the use of the stone, concrete or brick arch, rather than a structure with straight lines. That there are many arguments in favor of the use of arches in such locations as fine residential sections of the city, parks, boulevards and in locations where the topography admits of ample head room there can be no question. The problem here is rather to secure a structure with minimum height to provide the necessary clearance, of maximum width, noiseless as possible, and of good sightly design, than to seek for purely aesthetic effects.

The use of the arch reduces head room on the sides of the street, and tends to materially lessen the light under the structure. Present day methods of concrete construction insure that with proper specifications a durable and pleasing surface can be secured, and fine artistic effect can be had by the use of good lines and proper finish of materials.

Much thought has been given to questions of design, and it is the conclusion that for a general standard of construction the concrete bridge with simple straight lines, will be far more satisfactory than the arch in nearly all locations and will be subject to such artistic treatment in the way of balustrades or coping as will best conform to the surroundings.

In an appendix to the above-quoted report an abstract of the laws governing grade separation in various states is given from which the following is taken:

Eighteen states have as yet no laws regulating the work of grade separation and where within their boundaries any of this work has been done it has been arranged by agree-

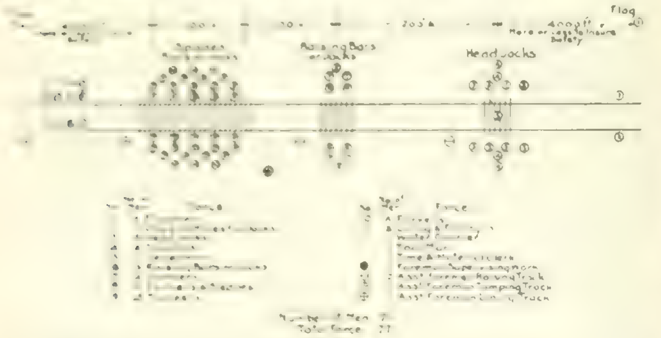
[illegible] Twenty-two states [illegible] the division of [illegible] railroad commission [illegible] Massachusetts, [illegible] per cent and the [illegible]

[illegible] Detroit City En[illegible] in January, 1917, with [illegible] John W. [illegible] and Prof. Henry E. [illegible] consulting engineer [illegible] a study of the [illegible] for the city.

Ballast Gang Organization

[illegible] of Ballast of the American Railway Engineering Association sent out to the various railroads a tentative diagram showing the organization of a [illegible] and criticisms.

After receiving the replies the committee modified somewhat its tentative diagram and presented it at the March con[illegible]. This [illegible] is reproduced below. In this diagram it is presupposed that old track has been skeletonized and that a follow-up gang will do the finished lining and dressing, after the track has been pounded down under traffic. The skeletonizing gang should precede the raising [illegible] one day's work. Slow order should govern train movements over skeletonized track as well as the track being lifted. Lifting jacks should be set away from the joints preferably at least two ties. Ties should be respaced if necessary particularly at the joints.



Suggested Organization and Distribution of a Ballast Raising Gang.

Some additional suggestions received by the committee were as follows:

Some railroads claim it is helpful to number the men and chalk their numbers on the rail over the particular ties these men are to tamp.

Others suggest that the head flagman, whose duties will be light, can tighten bolts and in some instances dig jack holes. The rear flagman can put on rail anchors and tidy up without interfering with his job. This presupposes that the flagging will be done by one of the ballast gang as would be the case on a new line. If regular trainmen are used on an operated line, such work presumably could not be required from them.

Several comment that a tamping spade, heavy and narrow, is better than pick or bar for the first tamping after a raise.

Agreement is pretty general that on an operated track, an advance gang digging out spent ballast, widening shoulder, renewing ties and making general preparation for the spreading of the new ballast, should be handled as a separate unit well in advance of the ballast gang. If track has to be lowered under overhead obstructions, bank widening is required or similar work has to be done. This preliminary work may require a large force and special facilities.

$8,000,000 Rapid Transit Line Opened at New York City.—The Clark St. tunnel line of the Interborough Rapid Transit Co., New York City, was placed in service on April 15. The new line has been under construction since 1914 and will cost completed between $7,000,000 and $8,000,000. The line includes twin tubes under the East River.

Convention of American Concrete Institute.—The next annual convention of the American Concrete Institute will be held June 27-28 at Hotel Traymore, Atlantic City, N. J.

Adaption of Motor Trucks for Hauling Cars on Light Railways

An ingenious arrangement by which a motor truck is utilized for haulage purposes on pioneer light railways has been developed by a South African engineer. The plan is described in the South African Journal of Industries by the inventor, Mr. Frank Dutton.

The truck is adapted for rail haulage by fitting the front axle with a ball socket and attaching a 4-wheel rail bogie to support the front part of the truck. The front wheels of the truck are raised up clear of the ground when the outfit is running on rails. The driving wheels of the truck, shod with solid rubber tires, run on prepared strips of road metal on each side of the railway track. The weight is so distributed that 3,000 lb. rests on the rails and 5,655 lb. on the driving wheels. The arrangement is such that the truck can, in a few seconds, be converted from road to rail or vice versa.

The system was tried out last summer near Johannesburg, South Africa, on a test section of track. The rails used on the section were the ordinary mine track type, weighing 16 lb. per yard and were supported on the usual light steel sleeper weighing about 6 lb. The rail sleepers were not ballasted, but were laid on the gravel and dirt as found on the site. The wheelways for the driving wheels were comprised of the same material and received no preparation whatever, beyond the pressure of the wheels of the truck running over them a few times. Other difficulties were incurred, such as putting the super-elevation on the wrong side on curves, using crippled second-hand track, or check rails on curves, and similar modifications.

Truck Equipped for Operation on Light Railway.

Fairly long grades of 1 to 17 and 1 in 18 were used on the straight, though there is a grade of 1 in 18 on a 100-ft. curve. This is equivalent to a grade of 1 in 14 on the straight.

One of the most remarkable features of the test was the accuracy with which the driving wheels aligned themselves to the setting of the steering bogie on the rail track. No matter how many times or in which direction the truck ran over the course, the driving wheels followed the same track exactly. The cars used on the trial were high-sided bogies with a floor space 16 ft. long by 5 ft. 6 in. wide. The test load of 16 tons was made up with railway sleepers. It was found that the truck rode easily at 18 miles an hour and took the 50-ft. curves at 12 miles an hour with perfect steadiness. The truck could stop and start with a full load on any grade or curve on the trial track, without any jerking or slipping, and this with the full weight of the train hanging on.

Intensive Training and Essential Production.—In a written discussion presented at the last annual meeting of the American Society of Mechanical Engineers, Mr. H. E. Miles stated that usually the powers of the individual man drawn upon did not exceed 40 or 60 per cent of his possibilities, leaving him a great reservoir untapped. He pointed out that the war had taught us to utilize this; that it had taught us to train in six weeks where years were needed formerly in the wasteful apprentice system. He believed that the value of the practice of intensive training taught by the war has been proven in many factories and was about to be accepted as a part of the essential production program of every first-rate shop.

Concreting Plant for Boston Dry Dock

A concreting plant, notable for its labor saving features, was employed by the Holbrook, Cabot & Rollins Corp. in the construction of the state dry dock at Boston, Mass. The dock is 1,200 ft. long, 150 wide at the top and contains over 116,000 cu. yd. of concrete. The sand, gravel and cement were conveyed to the mixer house by belt conveyors. The concrete was transported by special cars hauled by gasoline locomotives. The placing was done by a traveling tower.

The mixer house was a 4-story timber structure 20x24 ft. in plan and 56 ft. high. The two mixers set back to back were located at the bottom of the house. Above them was the charging floor, and above that were the sand and gravel bins. These bins had a capacity of about 130 tons of material. The cement was stored on the top floor, about 150 sacks being kept there.

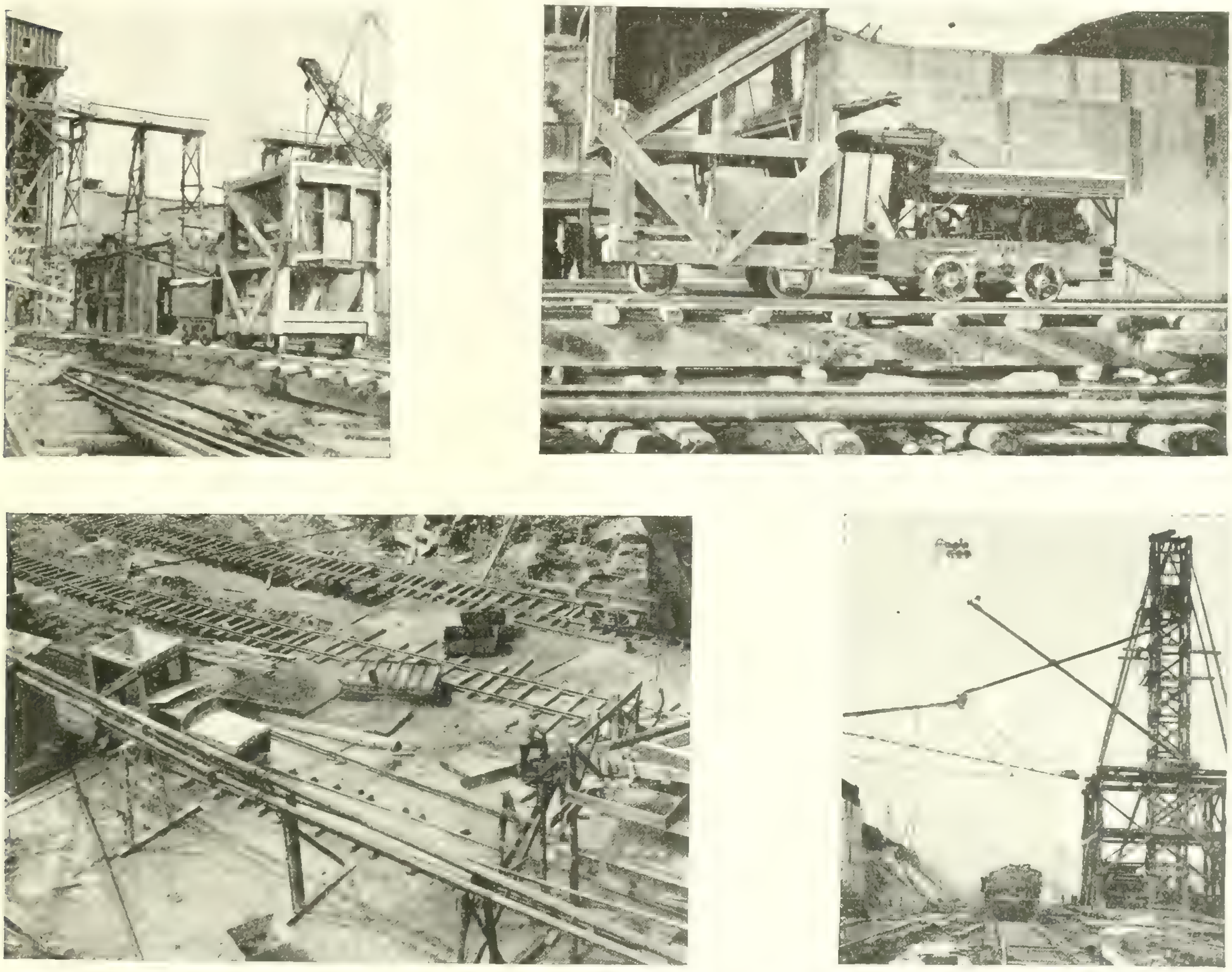
The batches were measured in two boxes on the charging floor and were discharged into the mixers below through special metal chutes which took the place of the regular mixer hoppers. The water tank also was on the charging floor.

The concrete was discharged through metal lined chutes to a main outlet chute which discharged into a 75 cu. ft. hopper car. This car was hauled by a Plymouth gasoline locomotive to the distributing tower. The haul was over standard gage track, laid along the center line of the dock. The run between the mixers and the elevator was 300 ft. and the locomotive and car was able to make the round trip regularly in 2 minutes, this including the time required to load the car, through which the sand was discharged onto the belt conveyor. The gravel was unloaded from the barges by a 15-ton travel to elevator, empty into elevator bucket and return to mixers.

The distributing tower consisted of a 30 ft. high 30x36 ft. traveling frame running on 16 22-in. wheels on a 30 ft. gage track. The frame carries a 50 ft. high 8 ft. square hoisting tower built of timber. The concrete from the 75 cu. ft. car was discharging into the bucket of the hoisting tower and elevated to a receiving hopper, whence it was chuted into place. The 50 ft. sections of the distributing chutes were suspended from the tower by a timber boom.

With this outfit the manual labor required was reduced to a minimum. The concrete agrgegates were delivered in barges. The sand was placed in a large hopper by a clamshell operated from a stiff leg derrick. The hoisting engineer operated both the derrick and the gate in the hopper crane and clamshell and discharged through hopper gates onto a belt conveyor. The sand conveyor was operated by a 10 h. p. motor and gravel belts by 5 h.p. motors. The conveyors had a delivery capacity of 115 tons of aggregate per hour. The cement came by rail, and was stored in two houses. A conveyor belt running through the center of one of these houses carried the bags of cement to a metal lined chute in the mixer house adjacent to the cement hoppers. The other cement house was used only for storage purposes.

In the mixer house also very little labor was needed. The sand and gravel were chuted from bins into the measuring boxes on the charging floor and cement likewise was sent down in chutes. The lower end of the latter chutes consisted of a length of 10 in. iron pipe. The upper part of the chutes had flaring hoppers set in the floor. The cement for each batch was emptied into the hoppers and held there by sliding metal gates until the signal was received from the charging floor.



Upper Left View—75 Cu. Ft. Capacity Concrete Car. Upper Right—Concrete Car and Locomotive. Lower Left—Discharge End (at Right) of Mixer Plant. Lower Right—Concrete Distributing Tower and Chutes.

Methods of Cleaning Track Ballast

Methods of cleaning track ballast was one of the subjects reported on by a committee at the recent convention of the American Railway Engineering Association. As a matter of information the committee submitted as a part of its report a copy of some instructions which were issued some time ago to certain division engineers on the Pennsylvania Lines West of Pittsburgh by Mr. W. C. Cushing, Chief Engineer of Maintenance. These methods are being tried out and when the supply of railroad labor gets back to a more nearly normal condition it is hoped that some definite conclusions may be reached as to their comparative value. Meanwhile it is considered that the description of these methods is valuable enough to warrant publication. The instructions follow:

Ballast Cleaning Not in Connection with Tie Renewals.

The space between the ties (cribs) to be cleaned to the bottom of the ties, the space between tracks to be cleaned to 6 in. below the bottom of the ties, and the shoulders outside of the ties to be cleaned down to the top of the subballast, if there is any. Where there is no subballast, clean to the sub-grade. Every 50 ft. one crib to be cleaned out to a line on a uniform grade between the bottom of the center ditch and the slope outside the track to form a cross drain from the center ditch.

Ordinary Fork Method.—Under the ordinary method, the ballast to be cleaned in the usual manner by shaking the ballast on forks and throwing the cleaned ballast remaining on the forks back into the track, and the small particles of ballast and dirt which pass between the tines of the forks to be disposed of by throwing it over the bank, or by any other way that may be expedient. When the dirt can be disposed of by throwing over the bank, its cost may be included in with the cleaning. When it is necessary to move the dirt any distance it shall be thrown into piles and the cost of doing so included with the cost of cleaning, but the cost of removing it afterwards shall be kept separate and not made a part of the cleaning cost.

Under this method of cleaning it will not be necessary to use a definite number of men in the gang, but it should not be extra large, nor very small. On double track there should be three men in each sub-gang: one on each berme and one in the center. The man in the center to work to the right or left as needed, and those on the sides to work in through the cribs to meet him. The sub-gangs to be started about 100 ft. apart. Thus, with a gang of 12 men they would be spread out over about 300 ft. of track. When starting, the ballast removed will have to be piled up until a space about 3 ft. is cleaned, after which the shaken ballast can be thrown directly back into the track in the 3-ft. space.

Trench-Zepp Method.—For this method three screens are to be used with a force of 12 men and a foreman, distributed as follows: Two men to shovel from each shoulder to their respective screen; two from the center into the center screen, and one man in the center of each track shoveling into the screen most available; one man with a pick working ahead to loosen hardened ballast, and three men, one for each screen, to dress down the ballast on the center and shoulders, form a uniform ballast line and dispose of the dirt. When the dirt can be disposed of by throwing over the bank, its cost may be included in with the cleaning. When it is necessary to move the dirt any distance it shall be thrown into piles and the cost of doing so included with the cost of cleaning, but the cost of removing it afterward shall be kept separate and not made a part of the cleaning cost. When necessary, a water boy in addition to the 12 men can be employed. In operation, the center screen will work ahead of the side screens, and the man attached to this screen will work ahead of the side screens and the men attached to this screen will clean out the cribs, to about 1 ft. inside of the inside rails of the double track.

Ballast Cleaning in Connection with Tie Renewals.

Ordinary Method.—Under this method such ties as are spotted are to be renewed in the ordinary manner with the ordinary sized force.

Screen Method.—By this method such ties as are spotted are to be renewed by a force of 8 men and a foreman with one screen, and a water boy if thought expedient. The force is to be distributed as follows:

One man picking ballast loose ahead of the gang.

Three men digging the ballast out of the track and throwing it onto the screen.

One man removing the refuse and straightening up the ballast.

Two men removing the spikes, taking out the old tie, putting in the new tie and spiking.

One man following up about 300 to 400 ft. in the rear, putting ballast in around the tie and trimming up the track.

All the ballast on the shoulder and in the cribs is to be taken out, but not from the center between tracks (this can be cleaned at another time). Where only one tie is to be renewed clean out the cribs on both sides of the tie. When two ties are to be renewed clean out the crib between the two ties and one crib on the outside of each tie or three cribs. When three ties are to be renewed clean out four cribs, etc.

The work to progress as follows: The first man with a pick will proceed to pick loose the ballast where ties are spotted. The three men cleaning out the ballast from track will follow about 12 ft. behind and shovel onto the screen. The one man in charge of the screen will see that the ballast falls onto the track, into pans, or on the outside shoulder, as may be deemed best in each case, for re-use in tamping the new ties. It is left in this shape until the two men who are putting in the ties come along. They will take out the spikes, remove the old tie, put in the new tie and tamp immediately, leveling off enough ballast into the cribs to make the track safe. The man who follows up in the rear is not started until the other force has proceeded far enough to allow as many trains to go over as may be deemed necessary by the foreman to settle the ties and permit of proper retamping, the idea being that the retamping after traffic has gone over it will all be done before the ballast is filled in to its proper section, so that it will not be in the way of tamping.

Cost of Operating Ford Car on Contract Work

The following data relate to the cost of operating a Ford car used on contract work in Southern California. The observation covers a period of one year, Sept. 1, 1918, to Sept. 1, 1919. The work consisted in transporting men and small tools on scattering concrete jobs and was mainly on paved roads in a level country.

The depreciation was based on a valuation of $350 for the machine at the end of the year. The distance covered was 9,100 miles. Interest was figured at 6 per cent. An average of 24.4 miles per gallon of gasoline was obtained.

	Per mile.	Total.
Interest and depreciation	$0.01188	$108.13
License fee and taxes	.00164	14.99
Gasolene, 376 gal. at 21 ct.	.00868	78.96
Oil, 16 gal. at 50 ct.	.00088	8.00
Miscellaneous supplies and repairs	.00100	9.10
Tire expense	.00976	88.80
Total	$0.03384	$307.98

We are indebted to Mr. R. H. Elsea, contractor, Ontario, Calif., for the above information.

Heat Treatment of Rail Joints

A report of some tests on splice bars made at the Altoona Laboratory of the Pennsylvania Railroad was included in a committee report made at the March convention of the American Railway Engineering Association. Probably the most interesting part of this report is the data given on the effect of heat treatment in increasing the stiffness of rail joint bars. This treatment consists in heating the material to approximately 1,500° F. and quenching in water from that temperature and then annealing the hardened steel at a temperature of approximately 1,050° F. This adds a few dollars per ton to the cost of the steel, but in view of the results shown in the table below, it is considered that this will be worth while:

HEAT TREATMENT RESULTS

Type of Bar or Splice Bar	Elastic Limit of Joint or Rail. Before treatment.	After treatment.	Gain in per cent.
Solid rail, 100-lb.*	175,000	280,000	60.0
Solid rail, 125-lb.*	220,000	375,000	70.0
Plain bar, No. 8, four-hole	50,000	125,000	150.0
Plain bar, No. 8, six-hole	70,000	125,000	79.6
Continuous bar, four-hole	130,000	210,000	61.0
Bonzano, four-hole†	120,000	255,000	112.0

*High carbon steel. †Chrome nickel steel.

How Shall Proper Recognition of the Engineering Profession Be Obtained?*

By W. W. K. SPARROW,

Chief Engineer, C., M. & St. P. R. R., Chicago, Ill.

There is a regrettable lack of recognition of the engineering profession, not only in the matter of compensation, but also in the administration of public affairs. As an illustration of this, take the present administration of our great railway systems, the greatest in the world, and largely the handiwork of our profession. It seems to me that if there is one position in the cabinet of the Director General of Railroads which the engineer is peculiarly fitted to fill, it is that of Director of Capital Expenditures. The problem of the development of our railways, their economic requirements in the way of additional facilities and improvements, is certainly largely an engineering one. While this is evidenced by the fact that practically every employe in that department is an engineer, and in every case the assistant to the Regional Director in charge of capital expenditures is also an engineer, yet we find this important position first occupied by a lawyer and now by a gentleman who graduated from the traffic department of one of our railroads. The same lack of recognition is found in the representation of the Interstate Commerce Commission, a body charged, among its other important duties, with one of the greatest economic and engineering tasks of the day, viz.: the valuation of our railroads and in like manner in the representation of the State Commissions, the National Commission on the development of waterways and other similar bodies.

This lack of recognition is sometimes almost grotesque as, for example, when a few years ago the Governor of the state of Missouri appointed a lawyer as State Highway Engineer of that state.

While in the past few years engineers have received greater recognition, as for example in the appointment by the Federal Government in August, 1915, of the Naval Consulting Board, consisting of two representatives from 11 engineering and scientific societies to co-operate with the Naval Advisory Board for the purpose of obtaining the most advanced experience and thought in technical research and engineering developments; in the important positions some have been called to fill in the administration of the affairs of our large railroad corporations, in the situation they at present find themselves, and also in the administration of the municipal affairs of some of our large cities in the capacity of City Manager, yet I feel that the profession is far from taking its proper place in the affairs of our nation, states or cities. I think that this is more marked in the United States than in some other countries, at least that was the impression I gained when I first came to this country. It is certainly true of England and South Africa, where I spent some years of my life. Just about the time I left South Africa where, by the way, the railroads and harbors are all Government owned and operated, it was decided to change from the British system of organization to the American system and it was interesting to observe that the greater number of the newly created general superintendents and superintendents were drafted from the engineering department. This may have been due to some extent, to the fact that under the British organization the engineering department has complete charge and supervision of all track and structures, but I think it was also largely attributable to the standing and recognition attained by the engineering profession.

I have dealt somewhat at length on what I believe we all recognize—the failure of the engineering profession to take its proper place in the ranks of society and the affairs of our country not only for the reason that I believe that with a better understanding and appreciation of the engineer's work on the part of those outside the profession, and the service he renders to our industry, health, comfort and welfare, would come more liberal compensation, but also because I have lost none of the ideals of the greatness and nobility of the profession and the desire, which I am confident you all share, to see it receive at the hands of the general public the recognition and standing which as one of the greatest professions of the world it ought to receive. I believe there will be little or no disagreement with what I have said so far, in fact I think it is a condition of affairs we have recognized for some time and what we are most interested in is not a discussion of this situation, but how to remedy it.

I think the training of our profession teaches us the law of cause and effect, and that to every action there is an equal and opposite reaction. Consequently, there must be a cause for this lack of recognition and interest in us. Therefore, before prescribing a remedy, we must first ascertain the cause. To me the answer to this question is largely our own lack of interest in affairs outside of our profession, and also our lack of organization and concerted action. The engineer, as a rule, is diffident and modest; he has stood aloof from and taken little interest or activity in matters of public and political importance, and the activities of our societies and associations have been largely, if not exclusively, confined to technical matters within the profession, and even in those affairs little or no effort has been made to bring to the attention of those outside of the profession the part that it has taken and is taking in the progress of the world. I have stated that as a profession we have taken little interest in other than technical matters and as an illustration of how the profession suffers as a result of such lack of interest, I would call your attention to the Newlands Bill, introduced in the United States Senate at the first session of the 64th Congress, for the purpose of creating experimental stations in engineering, similar to the experimental stations already inaugurated in agriculture. The introduction of the bill was the result of the awakening which the war produced and which led to fresh and renewed activity among the advocates of Federal support for technical and engineering research, which it was felt would greatly assist in the development of all industrial resources. The bill failed and I am sorry to say that its failure was mainly due to the lack of active interest on the part of engineers and those interested in the development of our industries.

Another contributory cause is, in my opinion, the absence with few exceptions of state or national regulation in the practice of the profession. In the majority of our states any one who so desires may start to practice the profession of engineering without let or hindrance. Our profession in this respect is in about the same position as the medical profession was about 100 years or more ago when any apothecary could practice medicine, just as any plumber can today practice engineering as a sanitary engineer. Everyone today knows that a doctor must be licensed by the state to practice medicine and that before he is able to obtain that license he must be properly qualified. In England the social class is, or was, more distinctive than in this country, and there was, and is, unless the war has eliminated it, still a distinct line of separation between classes and the social class to which he belongs is distinctive of a man's position in life. Before the medical profession was subject to state license and when any "quack" could legally practice medicine, a doctor or "leech" as he was often termed, had little or no social recognition and ranked in about the same class as an undertaker. In England today the medical profession has taken its place in society and receives the recognition of all, and the first step in placing it on the plane it now occupies was in requiring everyone who practiced medicine to be licensed to do so by the state.

In South Africa land surveyors or Government land surveyors as they are known there, must be licensed by the state to practice. In transferring or subdividing land the deed or legal document must be accompanied by a plat giving the necessary information in a prescribed manner prepared by a Government Land Surveyor. The plat and survey must be submitted to the Surveyor-General's office, where it is checked and a record made of it. No transfer, subdivision or plat of land has any legal standing unless the work is done by a Government Land Surveyor and the survey passed through the Surveyor-General's office. The qualifications of Government Land Surveyor are high. He must pass a very rigid theoretical examination and if succesful in that, a practical one. It requires about 3 years' hard work to qualify. The result is that the Cape Government Surveyor has regular fees which give him a better return than the average engineer in that country, and his profession, which is only the kindergarten of engineering, has received recognition and standing both in the country and out of it. I have heard it said on more than one occasion, and I believe with truth,

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*From an address delivered March 17 at Railroad Conference, Chicago.

[illegible] been brought [illegible]

[illegible] education, which I [illegible] technical lines and not enough [illegible] general nature. The result is that the outlook and view of the young engineer leaving college is inclined to be too narrow and technical and he is often not sufficiently well informed upon or his interest [illegible] technical nature.

Summarizing what I have said, my views as to the three prime requisites to obtaining greater recognition for the [illegible] as follows:

1. [illegible]
2. Licensing.
3. Broader education, interest and activity in other than purely technical matters.

A letter, in a recent issue of the News Record, advocated an Engineering Union affiliated with the American Federation of Labor, and I desire to state clearly and beyond possi- [illegible] I am unalterably opposed to [illegible] labor unions, or per- [illegible] to the methods adopted by those unions, as it is not the organization, but their methods to which I am opposed. The question of organization is receiving the thought and attention of many engineers and we must be quite clear and definite as to the kind of organization we want.

It would be outside the range of this discussion to enter into an argument upon the merits and demerits of the struggle between labor and capital, but I am convinced that the engineering profession as a whole would never countenance the adoption of methods destructive to our economic welfare. Strikes and lockouts are economically unsound, and an extensive application of the movement must inevitably lead to economic disaster. No matter what the argument, genuine or specious, made in support of the use of the strike threat, the cumulative result is the undermining and destruction of governmental authority and industrial enterprise. Our profession is constructive, not destructive, and we cannot countenance for a minute the adoption of such methods. There are other objections to the methods of trade unionism, one of which is that it destroys the individuality and initiative and tends to reduce the efficient to the level of the inefficient.

It is not, in my judgment, necessary, in order to secure recognition of the qualifications and accomplishments of the engineering profession and readjustment of the compensation paid, so as to be adequate for the services performed in comparison with and in relation to the compensation paid to others, to resort to or adopt the methods of organized labor, and to do so would lower, instead of raise, the standards of the profession. Unity and concerted action are, however, necessary, and what I would like to see brought about would be an organization known as the United States Association of Engineers, similar to the United States Chamber of Commerce, which is the national organization of the business men of America, and which would embrace all branches and existing organizations, civil, mining, electrical and mechanical. Such an organization would have for the different branches of the profession, its section devoted to technical discussion and research; its section devoted to the promotion of the economic welfare of the engineer; its section devoted to matters of political and public interest, as for example, education of public opinion to the advantage and desirability of having engineering representation on public bodies having to deal with questions and problems involving engineering knowledge and experience, the appointment of engineers to public positions, involving similar knowledge and experience, the adoption of a National Department of Public Works and many other similar and important questions. Such an organization, with its supreme, or chief executive council, made up of representatives of all branches of the engineering profession, would command the attention and respect of the nation.

This may seem to many an impracticable dream, but today when we are dealing with Leagues of Nations why not a league of the American engineering associations and societies? The framing of such a constitution ought to be simple compared to that of the League of Nations. Nothing, of course, can be accomplished without a start, and as a start we have the American Association of Engineers, the only engineering organization I know of in this country devoted to other than technical matters. Let us develop it and build it up along such lines that it will stand to the engineering profession in the manner that the Chamber of Commerce stands to the business men of America.

I am a railroad man and am speaking, I presume, largely to railroad men and, of course, that is the branch of the profession which, as railroad men, we are most interested in. At the present time I do not belong to the American Association of Engineers. I have, with the conservativeness of the land of my birth, hesitated in joining until I felt quite satisfied that the objects and methods of the association were along the right lines. I have reached my decision and am going to send in my application for membership this month and shall urge, not only railroad engineers, but every engineer of my acquaintance, to join the association and lend a hand. We should not rest in the organization of railroad affairs until we see every railroad in the country with its chapter or division of the American Association, with subdivisions over its entire system, each subdivision to have its own officers, reporting to the chief executive council for that railroad, which in turn would report to the railroad council of the National Association. Let us invite the co-operation of our sister organization, the American Railway Engineering Association, and build up a nucleus of a National Association, embracing all branches of the profession.

While urging complete organization of railroad engineers, I do not want anyone to go away with that as the goal in view. A small organization of one section of the profession will not accomplish the desired result. We must have an organization which, when it speaks through its duly elected representatives, will speak for the whole engineering profession of the United States. That voice, gentlemen, will be heard and listened to. We railroad engineers can, however, set the necessary example and strive to organize the railroad section of the National Association in such a manner that it will serve as an incentive to other branches of the profession to do likewise.

Whether for good or for ill, the individualistic age is almost a thing of the past. We have in the last 10 or 15 years seen some great changes, but the changes in the next 10 or 15 years will, I think, be much greater. It is not so very long ago when a man could beat his horse or his child as much as he liked. Today he cannot, and as an illustration of the restriction that is being placed on the individual, he has not, or soon will not have the privilege of abusing himself by drinking what he likes.

The movement of the day appears to be in the direction of organization by classes, and the engineering profession ought to be, and I trust is, alive to the movement. Therefore, let us invite the co-operation of all and use our influence in every direction to build up a National Association which will embrace all branches of the profession and have as its object not only the advancement of technical research, but the economic, social and political welfare of the profession as a whole.

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700 Miles of New Railway Under Construction in Mexico—Manuel Aguirre Berlanga, Secretario de Gubernacion of the Mexican Government, has officially announced that construction is now in progress on about 700 miles of new lines of railway. This work is being done at the joint cost of the federal government and the states traversed by the roads. While the primary purpose of inaugurating extensive railroad construction at this time is to give steady employment to thousands of laborers, the new lines will also afford transportation outlets to rich mineral and agricultural districts. All of the materials for the building of these railroads are obtained in Mexico. The cross ties come from the native lumber mills and the steel rails are manufactured at the plant of the Monterey Iron and Steel Company.

New Shaft Sinking Record.—A new world's record for shaft sinking was made in December, 1918, at the Crown Mines, Johannesburg, South Africa. The shaft is circular, having a diameter of 20 ft. inside the walling. During December it was sunk 279 ft. from a depth of 655 to 934 ft., the average speed being 9 ft. per 24 hours. The cost of sinking, exclusive of walling, was between $62.40 and $67.40 per foot for the month. The previous world's record also was made at the Crown Mines, where 252 ft. was made in a 31-day month at the No. 14 circular shaft of the mines; this was also a 20-shaft. R. C. Warriner, 120 Broadway, New York, was Consulting Engineer at the Crown Mines up to the end of 1918.

Stripping and Drilling Methods at the Sacramento Hill Copper Mines

Systematic prospect drilling on Sacramento Hill by the Copper Queen branch of the Phelps Dodge Corporation has developed approximately 15,000,000 tons of copper ore averaging better than 1½ per cent of copper. The excavation and drilling methods that are being employed in opening up these newly developed ore bodies are described by Mr. Robert T. Banks in April Mine and Quarry, to which we are indebted for the matter in our article.

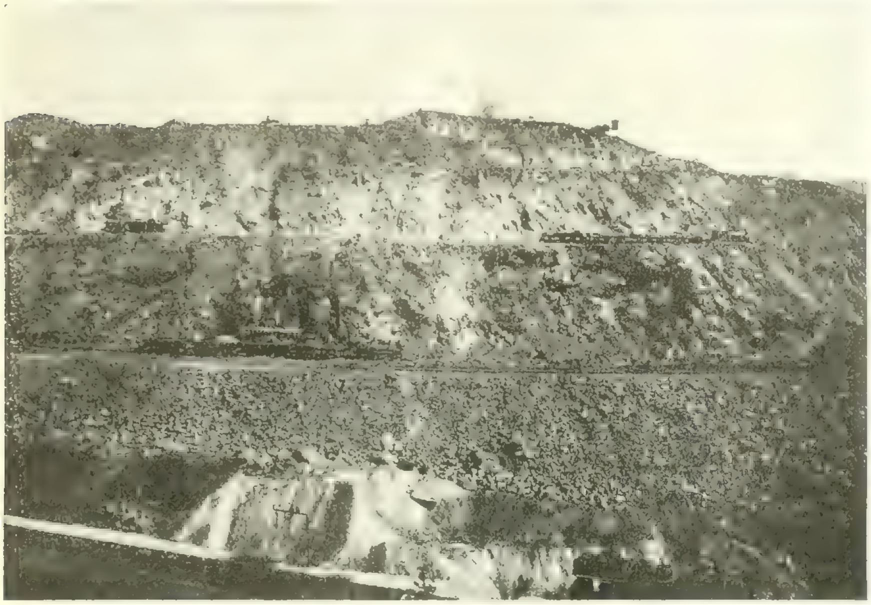

Fig. 1.—Arrangement of Benches on Sacramento Hill.

The ore developed is in two bodies, which have been named the east and the west ore bodies, and are separated by a comparatively barren strip of ground from 400 to 500 ft. wide. The west ore body, which will be mined first, is accurately defined and will produce something over 6,000,000 tons of ore. Drilling is still in progress on the east ore body, but sufficient has been done to insure a production in excess of 10,000,000 tons. The west ore body, considered as a unit, will average better than 2 per cent copper, which is considerably higher than the average of the working "porphyry" deposits in the United States. The east ore body will run lower in copper content.

Sacramento Hill, the most prominent physical and geological feature of the Warren district, is a massive granite porphyry block. Around its southern base in a semi-circle are grouped the mines of the Copper Queen and the Calumet and Arizona companies. From these mines over 4,000 tons of ore are hoisted daily and are shipped to the smelters at Douglas.

The hill itself, with reference to the newly developed ore bodies, is a capping of overburden or waste, and a large part of the hill must be removed before mining operations can begin. The stripping operations over the west ore body, which are well under way, as is shown in the photograph, require the removal of approximately 15,000,000 tons of waste before a pound of ore can be mined. About two years will be required to complete the stripping operations which will lay bare the west ore body. This in itself is an exceedingly expensive undertaking Every ton of waste is solid rock, which must be drilled and shot with powder before it becomes accessible for the steam shovels.

Bench Method of Excavation.—To carry on the stripping operations the hill has been laid off in benches as is shown in Fig. 1. The lower or "machine shop" bench is immediately over the ore body. The three benches above this are 60 ft. apart vertically. Each bench has its own steam shovel and trackage system, and the broken waste is placed on 20-ton side dump standard gauge cars. Because of the heavy grades required to reach the dumping grounds four cars constitute a train, which is drawn by an oil-burning locomotive.

Both churn drills and tripod drills are used in the rock breaking operations. From the bench above, 60-ft. churn drill holes are put down; and these are first "sprung," then loaded and fired by electricity. To relieve the churn drill holes, 22-ft. flat holes are drilled at the base of the bench by tripod drills. These also are "sprung" first and then loaded with two or three boxes of dynamite each. Because of extremely variable rock conditions no set rule can be applied to the spacing of churn drill holes. It is simply a case of "the harder the ground, the closer the holes and the heavier the charge."

Methods of Drilling for Toe-holes.—The Sullivan "Hyspeed" pistol drill with ¾-in. cylinder diameter was selected for this work. These drills have seen extremely hard service. The air for the piston drills is supplied from the Copper Queen power plant.

Each machine's crew consists of a Mexican runner and helper. The "toe-holes" are spaced approximately 6 ft. apart in hard ground and from 8 to 15 ft. apart in the medium and broken ground. All holes are drilled nearly flat with just enough down pitch to permit water to run into the hole. Solid steel with a cross bit is used and blow pipes are employed to help clean the holes.

In many places extremely difficult drilling ground has been encountered, the rock being unusually hard and at the same time "fitchery and cavey." Consequently many holes, after reaching a depth of 15 ft. or more, caved behind the bit, making recovery difficult. The extremely variable ground has made the keeping of accurate drilling records impracticable, but in hard ground one 22-ft. hole is considered a shift's work for a runner and helper. When drilling conditions are reasonably good a crew will drill two of the 22-ft. holes in a shift. All machines are mounted on heavy tripods, and as the ground is usually rough and covered with boulders considerable time is consumed in setting up and moving.

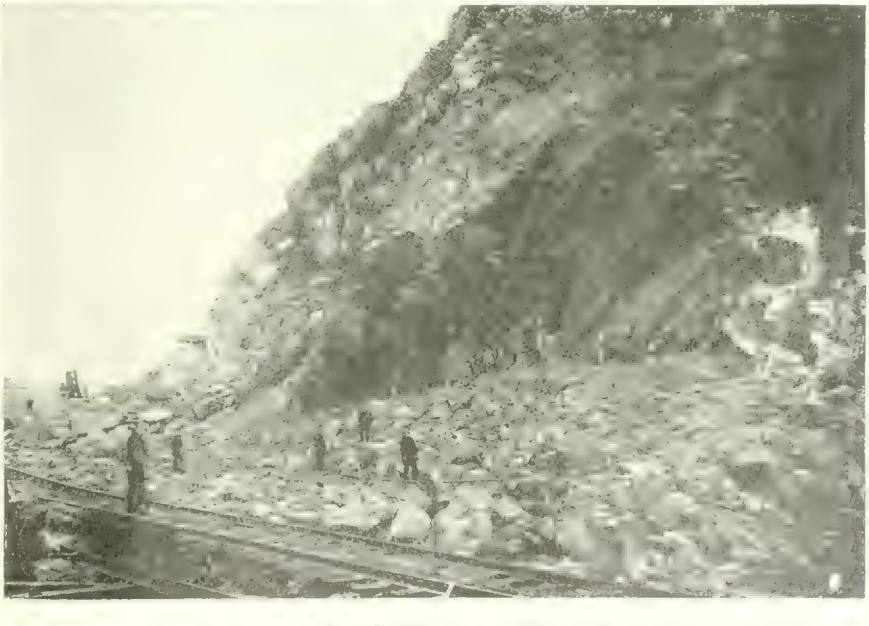

Fig. 2.—Drilling Operations on Upper Bench.

New Millsite Being Cleared.—[illegible] with the stripping [illegible] on Sacramento Hill the Copper Queen [illegible] is preparing a millsite for the erection of a [illegible] concentrator. [illegible] planned that the concentrator will be finished about the time the stripping [illegible] completed. Unless the [illegible] building is held up by unforeseen conditions, the mill will be [illegible] about [illegible] A small [illegible] has been in operation for some time and very satisfactory results have been obtained, [illegible] concentration and flotation.

[illegible] has been selected on the southern slope of the Mule Mountains [illegible] international border about [illegible] miles south of the Sacramento Hill [illegible] and [illegible] southwest of the town of Warren, Ariz. [illegible] tailings storage is provided for on the sloping [illegible] to the south.

Excavating with Rotators.—In preparing the terraces for mill floors extremely hard close grained quartzite [illegible] were encountered almost at the surface. At no place on the millsite is the [illegible] more than a few feet thick. Sullivan "D-P-33" hollow piston rotators were selected for drilling operations, the air being supplied through a 5-in. [illegible] line from the Copper Queen power plant. Even in the hands of inexperienced Mexican operators the upkeep on these [illegible] has been exceedingly small and a runner will drill a 100 ft. of hole per shift in the hardest quartzite. Sixteen of the Sullivan rotators have been in constant use since the work started. Hollow hexagon [illegible] steel with a cross bit is used and holes 4 to 6 ft. deep [illegible]. The drill steel is sharpened at the Copper Queen central shop.

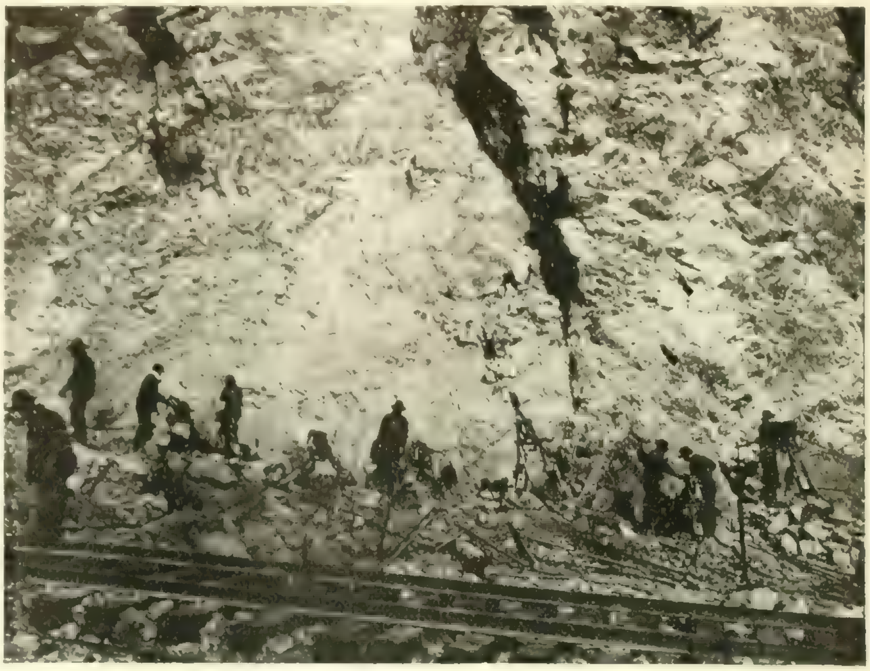

Fig. 3. Drills Working on Toe Holes, Sacramento Hill

Blasting Practice.—The management has been exceptionally careful in regard to the safety of the workmen on the millsite and has found it good practice to fire from 200 to 300 [illegible] at a time, giving the workmen ample opportunity to get out of range of flying rock. It is worthy of note that only one man has been injured on the works and this injury consisted of a slight scalp cut. This is probably a record, inasmuch as the work on the millsite has been in progress more than six months and not less than 125 men are employed.

Fig. 4. Excavation for Concentrator.

Dynamite as an Aid in Tree Planting

[illegible] advantage in planting trees. The method is as follows:

First, put down stakes where the trees are to stand. Then [illegible] or maul if necessary, put down a bore hole which would be about 1¾ [illegible] bore hole [illegible] place a [illegible] cartridge of low freezing 20 per cent dynamite into which a No. 6 blasting cap and length of fuse long enough to reach a couple of inches out of the top of the bore hole has been inserted. Tamp the charge in well with damp clay, loam or sand. Light the fuse and move about 20 ft. away. After the blast, dig out the hole being careful to locate and fill the cavity at the bottom. Fill in the hole with subsoil up to within about 3 in. of the point where the roots are to rest. Fill in that 3 in. and all around the roots with rich topsoil. If the soil is poor, place some manure or other suitable fertilizer in the bottom of the hole and be careful not to permit the fertilizer to come in direct contact with the roots. After the hole has been completely filled tramp the soil down firmly around the tree. If the soil is dry at the time the tree is being planted, it is well to pour water on it.

Low Alumina Cement Used in Grouting East Boston Tunnel

Neat cement grout made from a low alumina cement was used during the past year in grouting the East Boston Tunnel of the Boston Transit System. The grout was placed in cracks and relatively porous places, where small leaks occur in the arch and upper sidewalls, about 94 cu. yd. being used in the year. Practically all of the grouting was done between the pumpwell and Webster St. on the East Boston end of the tunnel. The average force employed has been one foreman and 14 laborers. The East Boston Tunnel is the first instance of which we have any record of a monolithic concrete tunnel having been built under salt water. It was constructed with the ordinary high alumina Portland cement at a time when there was less knowledge than we now have of the action of sea water on such cement. There was no waterproofing membrane between the concrete and the surrounding earth to prevent the water from percolating to the outside of the concrete. The leakage into the tunnel, however, is very small, states the last annual report of the Boston Transit Commission. The East Boston Tunnel differs from the recently built Dorchester Tunnel under Fort Point channel in that the two tubes of the Dorchester Tunnel have an outer shell of hard pine, between which and the concrete there is a waterproof membrane consisting of three layers of asphalt saturated waterproofing fabric with asphalt mopped on to the fabric, so that there are three layers of fabric and four layers of mopped asphalt between the hard pine outer shell and the concrete. The cement used in the construction of the Dorchester Tunnel was selected cement containing less than 6.5 per cent of alumina (A_2O_3), such cement being found by tests of the Commission to better withstand the effects of contact with sea water.

Tie Renewals, Use of Screw Spikes, and Substitutes for Timber Ties

At the last annual convention of the American Railway Engineering Association the committee on ties reported as follows:

The Use of Screw Spikes. In 1914, 27 out of 29 railroads who gave an opinion agreed on the statement "screw spikes prolong the life of ties over that obtained with cut spikes." Three years later a committee for the Pennsylvania R. R. finished an investigation on this subject, which it had conducted for 9 years, and agreed upon the following statement "Screw spikes have no advantage over nail spikes. When used with clips without tie plates, the cutting of the rail into the tie permits the rail to slip under the clip, thus widening the gage."

As a result of these divering opinions, the committee has tried to find the present general opinion among railroads on this subject, in the hope that they could summarize the practice and distinguish the conditions under which either form of track connection was the better as regards the durability of the ties.

For this purpose a list of questions was sent to 75 railroads. From these, 58 have replied, and of these 58, 52 stated either that they had never used any screw spikes, or else that their trials had been so limited that no conclusion could be formed. Of the other 6 replies, 2 railroads believed that screw spikes permitted a longer life of tie than cut spikes. Three railroads reported that screw spikes did not permit longer life of tie than cut spikes. One electric elevated and subway road reports that screw spikes do prolong the life of ties. Two railroads believed there was no reason for using screw spikes unless the ties were bored and treated before the screw spikes were applied. Six railroads considered this unnecessary. Eight railroads believed that a screw spike should not be used as an anchor, and that it should be kept free from the slots in the angle. Five railroads considered that it should be used as an anchor and put in the slots in the angle. One railroad used some device to put in the spike hole to make the screw spike secure again after it had become loose, or after the chamber around it had decayed. Eleven railroads used no such device.

One elevated electric road reported on the elevated structures and subways as follows:

"On the elevated structure and in the subways screw spikes can be installed or taken out as quickly as cut spikes. This is due undoubtedly to the limited space in which to work and the fact that screw spikes are installed or removed by means of pneumatic tools. Without question for this type of service, or any service requiring frequent renewal of rail, screw spikes will prolong the life of the ties and will result in better track."

Another railroad advised: "For ordinary maintenance no power tools are needed, but are of advantage for first installation; can be maintained by ordinary track labor."

As a result of these diverging opinions, it is the opinion of the committee—

(1) That there is not sufficient data available, due to lack of general use, to show that the use of screw spikes will increase the durability of ties, except under special conditions.

(2) That there may be specific forms of track construction where screw spikes prolong the life of ties such as on elevated structures, and so-called permanent track where there is a more substantial foundation provided than an ordinary tie and ballast track.

Controlling Tie Renewals.—The study of the replies to inquiries in last year's investigation of methods for controlling tie renewals indicates a wide divergence of methods under apparent similarity of organization and physical conditions.

This suggests the possibility of developing a uniform method of determining the essentials necessary to control tie renewals, namely:

(1) Preliminary physical inspection of ties in track—based on a predetermined renewal standard.

(2) Field checks of the preliminary inspection in whole or in part.

(3) Utilization of statistics as a further check on tie renewals and the determination of final allotment.

(4) Checking results obtained.

The tabulation of replies received from 100 railroads with an aggregate mileage of 223,000 would indicate that there are three general methods for determining the number of ties to be renewed.

(a) Field inspection by section foremen, supervisor or roadmaster.

(b) Inspection by tie inspector.

(c) Determination by statistics.

Evidence should be obtained to disclose which method is best suited to local conditions and type of organization to insure following predetermined standards of renewal and avoid divided responsibility for safe maintenance.

Information at hand does not indicate the best methods of obtaining effective field checks to secure economy and safety.

The best methods of final allotment of tie supply should be further developed.

It is evident that an inspection of ties removed from track affords the best means of checking extravagance and placing the responsibility for same. This leads to the determination of the best method for making an independent check and devising means for determining and avoiding inadequate renewals.

Substitute Ties.—Twenty-three railroads reported to the committee on the use of various steel and reinforced concrete ties. For the most part these reports were very brief and referred to very limited installations of substitute ties, from as far as three in number to several thousand. As is well known, the number of steel ties in service greatly exceeds the number of reinforced concrete. Owing to war conditions practically no new steel ties have been put in during the last year, even on those roads which at present have the greatest number in service.

The particular substitute ties reported as undergoing trial are as follows: Universal, Baird, Carnegie, Hardman, Simplex, Bates, Percival, Buhrer, Snyder, Goodlett, Standard, Leonard, Shane, Smith, Riegler, Alfred, and Wolf.

Several instances are reported in which it has been found necessary to remove steel ties on account of excessive corrosion, or to renew the rail fastenings for the same reason and on account of wear. Other roads report that so far their substitute ties are performing good service.

The life of a steel tie is still uncertain, depending considerably upon local conditions. Instances have been reported of their lasting but little longer than the best wooden tie, due to corrosion, web splitting and rivets becoming loose.

An instance is reported of an installation of reinforced ties (150 in number) which had to be taken out after being in the track but a few months, on account of a derailment which cracked and broke them.

Dust Eliminator for Cleaning Empty Cement Bags

A simple and efficient device is being used at the Englewood dam of the Miami Conservancy District, Ohio, for eliminating dust while cleaning empty cement bags. It consists of a box 6 ft. long, 3½ ft. wide, and 3 ft. deep, with a wooden air shaft running from the top of the box up through the roof of the cement shed. Three inches from the top of the box, the two long sides flare out, as shown, at an angle of about 45°. The box has a lid narrower than the width of the box so as to leave an open space about 2 in. wide between the long edges of the lid and the sides of the box, as shown. The empty cement sack is dropped mouth down through this 2-in. slot and shaken into the box. The effect of the ventilator is to prevent dust rising through the slot into the cement shed. The device, states the Miami Conservancy Bulletin, practically eliminates the dust, due to shaking empty cement sacks, so disagreeable to laborers, and reclaims fully twice as much cement as when the bags are shaken out as usual on the floor of the cement shed, or in an open box. Also twice as many bags can be cleaned in a given time as by the usual method. Eleven full bags of cement were saved from 1,500 bags cleaned. This device originated with John Owens, foreman of the Englewood gravel washing and concrete mixing plant.

Cross Section of Cement Bag Cleaner.

A Bold Experiment: The First Concrete Freight Car

[illegible] ship was one of the [illegible] during the war. Many [illegible] the seaworthiness of so [illegible] "Faith" has justified her name.

Not less bold, in its way, is the reinforced concrete freight car [illegible] after the designs of Joseph B. Strauss, civil engineer of Chicago. Fig. 1 shows the completed car ready for service on the Illinois Central Ry. Figs. 2 and 3 are views of the car during construction, showing the steel rods prior to being encased with concrete.

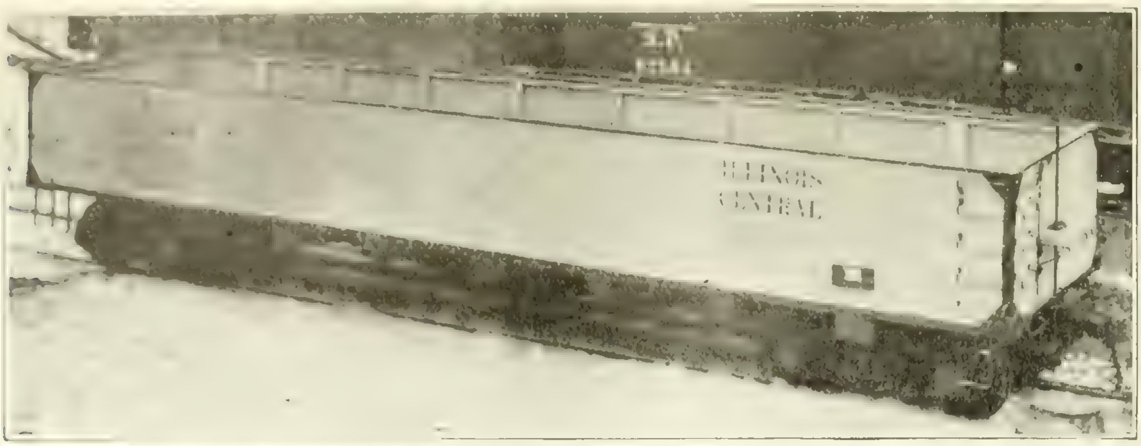

Fig. 1—Completed Car Ready for Service on Illinois Central R. R.

As compared with the ordinary all-steel freight car, a concrete car should have the following advantages: (1) Lower first cost; (2) lower maintenance cost, and (3) longer life. Steel cars require frequent painting, and are by no means as everlasting as was anticipated when they were first introduced in place of wooden cars.

If a reinforced concrete car will stand up well under the shocks of service and if its ratio of dead weight to load carried can be kept as low as that of a steel car, there is little doubt that reinforced concrete will displace steel cars just as steel cars have been replacing those of wood.

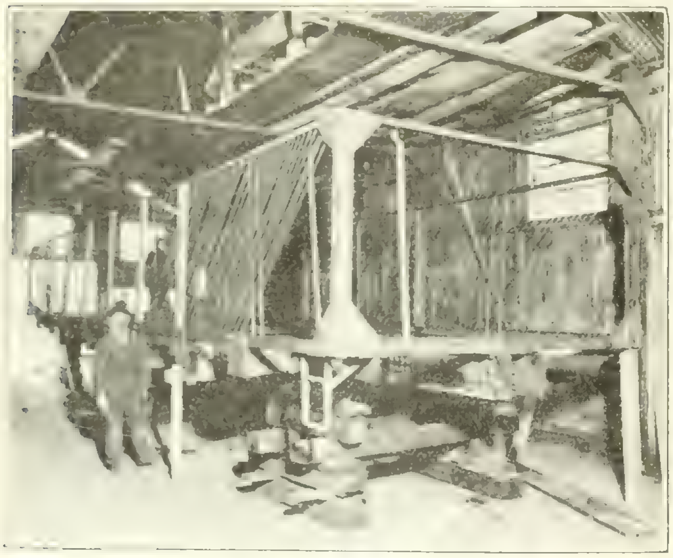

Fig. 2—Frame With Reinforcement Partly Completed.

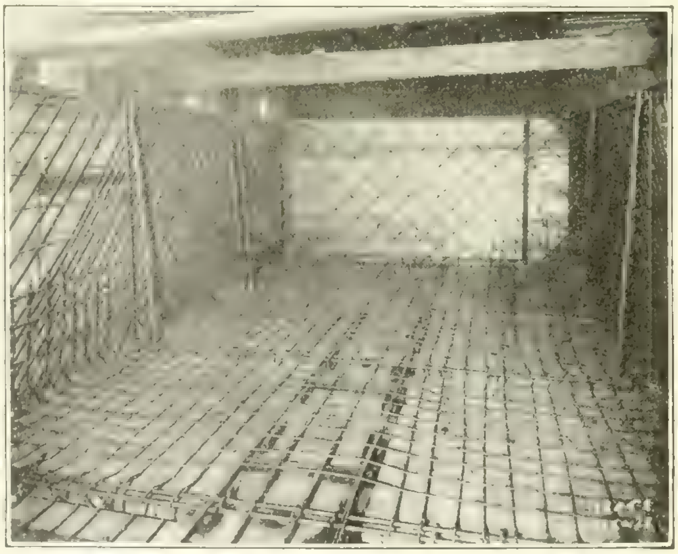

Fig. 3—Reinforcement in Place Ready for the Concrete.

This first concrete car has a capacity of 100,000 lb. and it weighs 53,600 lb. But the makers say that with proper facilities for construction the weight can be reduced fully 10 per cent. The average steel car of like capacity weighs from 43,000 to 45,000 lb.

For the concrete used in this construction the first commercial application of a new lightweight aggregate known as Haydite was made. This material is a result of a manufacturing process developed by Stephen J. Hayde of Kansas City, a concrete having a weight of 104 lb. per cu. ft. resulted, having a strength of 4,450 lb. compressive strength in 28-day tests.

Because the concrete sections on this car are thinner than ever before attempted in such concrete work, it was decided to use the cement gun for walls and floor. Cross-bearers were poured in the usual manner. Wood forms were placed on the outside of the car and the concrete was "shot" into place by compressed air. The resulting concrete is exceedingly dense and the finish remarkably smooth on the surface which was against forms. The interior surfaces were left more or less as produced by the cement gun. The use of the cement gun increased the unit weight of the concrete above that computed. As a result of this and the necessity of using heavier sections than required, the weight of the car when completed exceeded the computed weight by more than 3,600 lb. This experiment however makes it evident that with proper facilities for construction, another car of this size and design can be made to weigh somewhere between 46,000 and 48,000 lb.

This car was built with the sanction and co-operation of the United States Railroad Administration under occasional inspection by J. J. Tatum, supervisor of car repairs, acting under the direction of F. P. Pfahler, chief mechanical engineer, and Frank McManamy, assistant director of the division of operations. The Illinois Central Railroad took an active interest in the car and contributed many parts of the equipment.

In leading up to the construction of this first reinforced concrete gondola car, the Concrete Car Co. of America was organized with J. J. McCarthy, president of the R. F. Conway Co., of Chicago, Joseph B. Strauss and F. E. Sullivan, Chicago, as principals. This company is now actively developing plans for various types of concrete cars with a view to undertaking their manufacture on a commercial scale.

Salary Schedule for Railway Technical Engineers Adopted at Chicago Conference

Engineering departments from 54 railroads were represented at the national conference of railroad engineers held March 17 at Chicago under the auspices of the American Association of Engineers. Some 350 engineers attended the conference. The primary purpose of the meeting was to discuss conditions affecting the economic welfare of the railway technical engineer and to take steps to secure for him more adequate compensation for his services. The following schedule of minimum salaries for railroad professional engineers was adopted by the conference and has been submitted to the Government Wage Board at Washington:

Schedule of Minimum Salaries for Railroad Professional Engineers.

The duties of Resident Engineer involve construction work of ordinary magnitude. Where exceptional work is undertaken it is assumed that the Assistant District Engineer, District Engineer or Assistant Chief Engineer will take charge in the field.

The duties and qualifications attached to the positions named are generally well understood. Any schedule of rates promulgated should specify that the work actually performed should govern. Thus if a railroad calls a man an Assistant Engineer and he is actually performing the usual duties of a Division Engineer or other position, he should receive the pay of that position.

In the schedule the rates for the higher positions do not apply to short lines, terminal railroads and roads of similar character.

The rates of pay for the higher positions on the smaller roads to be in proportion to the duties and responsibilities assumed, based upon above schedule.

This schedule not to operate to reduce any salaries now existing.

Expenses away from headquarters or in connection with moving headquarters to be allowed.

No pay for overtime.

Civil service rules to apply as to annual and sick leave.

	Per year
Chief Engineer	$15,000 to $9,000
Assistant Chief Engineer	9,000 to 7,200
District Engineer	6,000 to 4,800
Assistant District Engineer	5,400 to 4,200
Division Engineer	4,800 to 4,200
Assistant Division Engineer	3,600 to 3,000
Resident Engineer	4,200 to 3,000
Office Engineer—Field Engineer	5,400 to 3,600
Engineer of Bridges	7,500 to 6,000
Assistant Engineer of Bridges	5,400 to 4,800
Signal Engineer	7,200 to 4,200
Assistant Signal Engineer	4,800 to 3,000
Building Engineer	6,000 to 3,000
Valuation Engineer	8,400 to 7,200
Assistant Valuation Engineer	6,000 to 4,800
Chief Pilot Engineer	4,800 to 3,600
Pilot Engineer	3,600 to 3,000
Engineer Accountant	4,800 to 3,000
General Superintendent of Motive Power	15,000 to 9,000
Assistant General Superintendent of Motive Power	9,000 to 7,200
Mechanical Engineer	7,500 to 6,000
Assistant Mechanical Engineer	4,800 to 3,600
Engineer of Tests	7,500 to 6,000
Electrical Engineer	8,000 to 6,000
Assistant Electrical Engineer	4,800 to 3,000
District Electrical Engineer	3,600 to 2,700
Shop Engineer	4,800 to 3,600
Chief Draftsman	3,600 to 3,000
	Per month
Leading Draftsman or Designer	200 to 250
Draftsman	150 to 200
Junior Draftsman	125 to 150
Tracer	100 to 150
Engineer Inspector	150 to 225
Instrument Man	200 to 225
Rodman	125 to 175
Tapeman	100 to 150

*Rates stated for junior positions cover the length of service in the respective position. An increase of not less than $5 for each 6 months' service to be granted up to the maximum rate of the position.

New Railways for Mexico.—President Carranza has asked the extra session of the Mexican Congress which meets May 1, to authorize the construction by the Federal Government of three railroad lines and the acquisition of another railway system. One of the proposed lines will run from some point on the Southern Pacific of Mexico between Magda and Hermosillo to Ensenada, the capital of Lower California.

Water Softening Plant on Construction Job Pays for Itself in Two Months

On many construction undertakings contractors are confronted with the problem of securing satisfactory water for the boilers of their locomotives, steam shovels and other steam operated equipment. This problem was satisfactorily solved by the Walsh Construction Co. on its grading contract at the Markham yards of the Illinois Central R. R. by the installation of a special plant for treating the water.

The contract involves the handling of some 1,500,000 cu. yd. of material for which the contractors are employing two steam shovels, six locomotives and two hoisting engines. When the grading was started last July it was discovered that the available water was so unsatisfactory as to cause serious difficulty in the operation of the equipment. The supply is obtained from a driven well about 170 ft. deep, the consumption being about 40 gal. per minute. The character of the water was such as to cause a very heavy scale formation, and much trouble with leaking flues and stray bolts resulted.

A water softening plant, supplied by the Railroad Water & Coal Handling Co. of Chicago was placed in operation on Oct. 27. This plant consisted of a 10-ft. diameter tank inside an 18-ft. diameter tank, both tanks being 18 ft. high. On top of the tank is a shallow mixing box. Raw water and reagents are pumped independently into the mixing box, from which they pass as a mixture through a 10-in. pipe extending almost to the bottom of the inside tank. The water escaping in this tank rises upward in the tank slowly while the chemical action is taking place, the solid matter precipitated in the meantime being deposited for the most part in the bottom of the tank, which is equipped with a sludge valve which allows the sludge to escape at intervals. As the treated water approaches the top of the interior tank it encounters a filter which consists of a diaphragm of excelsior interposed between two grids of wooden slats. Passing through this filter the water reaches the top of the interior tank, where it is allowed to escape into the outside tank through two 4-in. pipes extending from the top of the inner tank to near the bottom of the outer tank, the latter serving as storage for the treated water.

Conditions at the Markham yards are such as to give an exceptionally favorable opportunity for determining the economy of using treated water on a large construction undertaking. The job is isolated and all water for the entire work since the treating plant was installed is taken from the deep well and run through the treating plant. The following information furnished us by Mr. M. W. Woolsey of the Walsh Construction Co. should therefore be of interest.

The equipment used by the contractors includes two 70-ton steam shovels equipped with locomotive type boilers, in fuel and water consumption practically equal with locomotives used; six 46-ton 6-wheel switching type locomotives, having 155 2-in. flues, 13 ft. 6 in. long, 180 lb. working pressure; one 40-HP. locomotive type hoist boiler; one 25-HP. upright hoist boiler.

All boilers were in good overhauled condition, when started on job July 24, 1918. The normal equipment working day shift was two steam shovels, four locomotives hauling dirt, 1 locomotive switching and spreading and one locomotive for reserve. Working on night shift was one steam shovel, and three locomotives hauling and spreading.

Before starting to use treated water, the contractors were having engine failures nearly every day, practically all stay and crown bolts, flues and mud rims were leaking more or less. Repairs were good for about three days on an average. The time required to make repairs was 3 to 5 hours for each boiler. Electrically welding flues helped for a time, but in three weeks the leaking condition was about the same as before welding, though undoubtedly it would have been much worse had they not been welded.

During the untreated water period the contractors moved a total of 316,224 cu. yd. of dirt and used 2,756 tons of coal, which, assuming that the cost would be $3.50 per ton, would mean a coal cost of $.0306 cu. yd.

During the treated water period 335,075 cu. yd. of dirt were moved, 1,961 tons of coal at $3.50 per ton being used. This would mean a coal cost of $.0204 per yard or a saving of $.0102 per yard between using the treated and untreated [illegible] difference in [illegible] locomotive boilers.

The following [illegible] showing the results obtained during three periods on the [illegible] Yard work, the first period being [illegible] the beginning of the work [illegible] when the contractors were getting bad coal, the second period between [illegible] when they were getting the good coal, before the water softening plant was installed, and the period between [illegible] and Dec. [illegible] when they were [illegible] good coal [illegible] it along with the treated water.

[illegible] good coal a total [illegible] average [illegible] tons of coal per boiler shift at a total [illegible] or the yardage of [illegible] per yard.

[illegible] until the commencement of [illegible] water, the contractors worked a total of [illegible] although they used an average of 4.2 tons per boiler shift, they had an increase of 70 [illegible] During this [illegible] per cent over [illegible] the cost per yard to $.0300.

[illegible] until Dec. [illegible] boiler shifts and [illegible] tons per boiler shift, [illegible] yardage moved, meaning a [illegible] per yard or a saving of [illegible] per yard over the untreated water period and $.0172 per yard over the [illegible] which would mean a saving in coal alone, between the treated and untreated water periods, amounting to [illegible] per day, or more than enough to cover the cost of the water softening plant since its installation.

The cost of [illegible] work for the two months, September and [illegible] to using treated water, was:

	Average per day.	Per boiler day.
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	
[illegible]	[illegible]	$1.405

[illegible]

The cost of boiler work in January and February, two months' treated water period, beginning two months after using treated water, was:

LABOR COST.

	Average per day.	Per boiler day.	Material cost.	Total.
Boilermaker	$0.62	$0.07	$....	$.....
[illegible]				
[illegible]	[illegible]	[illegible]	[illegible]	96.45

The first item covers the running boiler work expense for this [illegible] cover the cutting out of 38 flues in [illegible] in order to clean out scale and mud in bottom of boiler, amounting to 10½ cu. ft.

Had all boilers been reflued the estimated cost per boiler, after taking a credit of 60 per cent for old flues, would have amounted to $277.73, including labor, or a cost of $1.84 per boiler day, estimating five months as the life of the flues. There would also be considerable stay bolt work upon which we have no data.

Spitting Fuse in a Wet Shaft.—In sinking the Leesburg shaft near Salmon City, Idaho, considerable difficulty was experienced in lighting the fuses for blasting, owing to the water that was encountered. The method of overcoming this difficulty is described by Mr. Frank B. Bryant in Engineering and Mining Journal, as follows: A 6-in. length of 2-in. shafting was drawn to a chisel edge at one end, the planes of the bit making an angle of about 60° with each other. The other end was drilled and tapped to [illegible] in., and a piece of ⅝-in. [illegible] threaded at one end was screwed in for a handle. When [illegible] in readiness in the shaft for the shooting, the top [illegible] the shooting iron to a bright red heat at a small forge [illegible] was lowered to the bottom. The water [illegible] in the shaft at about 1 foot per minute, so that it was necessary to float the fuses with wedges and blocks. One [illegible] held the fuses on a small block, while the other spit [illegible] with the heated iron. No delay was experienced, and two men were able to light as many as 22 holes at one time.

Draftsmen to Hold Meeting.—The Chicago local of the International Federation of Draftsmen's Union will hold a meeting at 1:30 p. m., April 19, at 73 W. Randolph street, Chicago.

Zinc Chloride Treatment for Railroad Ties

Interesting conclusions on zinc chloride treated ties were given by the Committee on Wood Preservation of the American Railway Engineering Association in its report submitted last month at the annual convention of the association. An abstract of the report follows:

Life of Zinc Treated Ties.—A careful study of the track records and personal conferences with those familiar with the use of zinc treated ties lead to the following conclusion as to the general service which may be expected from ties properly treated with this preservative. Proper treatment will at least double the life of an untreated tie in the same situation. To illustrate: If a pine tie would give 4 years' life untreated, eight years could be figured upon when treated with zinc chloride, and the same result would apply to other woods. To use another example: If an untreated Douglas fir sawed tie, where the rainfall is 25 in. or less, gives 6 years' life, it may be expected to last 12 years if properly treated and protected from mechanical wear. If this same tie, however, is used in a wet climate, say, of 40 in. rainfall or more, it would probably not give over 4 years' life untreated, but unquestionably would resist decay 8 years in the same climate if properly treated.

Influence of the Condition of the Wood Before Treatment. The experience of roads which have used zinc chloride treated ties clearly shows that the best results are obtaind only when thoroughly sound ties are treated. Undoubtedly, many of the poor results obtained with zinc chloride treated ties were due to the fact that many ties were more or less rotten before they were treated.

It is frequently stated that ties can be properly seasoned along the right of way or where cut, and that any deterioration can easily be detected by careful inspection. It has been demonstrated beyond all doubt that visual inspection of ties several months after cutting is not only impractical but frequently very misleading, because of the internal decay not evident on the outside.

The successful preliminary preparation of ties is one of the most vital factors in obtaining successful service, and it is necessary that ties in all stages before treatment be kept in well-ventilated piles, free from every possible kind of infection.

To help prevent these conditions, all ties should be shipped promptly after cutting to the seasoning yard at the treating plant. This means that all yards should be kept free from weeds, decayed wood and standing water.

Influence of Treatment.—One of the most striking conclusions obtained from the study made is that the quality of treatment has the most direct bearing on the ultimate life obtained. A well-treated tie gives appreciably longer service than a poorly treated tie. Poor treatment is caused by—

1. Excessive steaming of green or partially seasoned ties, in order to obtain any absorption at all. Even then the absorption is very poor.
2. The injection of an inadequate amount of zinc chloride.
3. Paying no attention to the relation between the strength of the solution and the duration of the pressure, resulting in a large amount of the zinc chloride, solution being compacted in the outer layer of wood, when it should have permeated the entire tie
4. The lack of intelligent and thorough inspection.

Leaching of the Zinc Salt.—One of the criticisms of the zinc chloride treatment is that the preservative, being soluble in water, leaches out and, therefore, can not be expected to give permanent protection. A general investigation of the results clearly indicates that the leaching process does not take place as rapidly as has been assumed. We have determined from an examination of ties which have been in the track for a number of years that they still retain zinc chloride well distributed throughout the tie. This is more noticeable in drier climates. The committee finds that while zinc chloride is a water soluble salt, it leaves the wood very slowly and that sufficient is retained in the wood fiber to give protection that will at least double the life obtained from the untreated wood.

Some years ago a series of leaching tests was made, taking twelve ties for each test. A careful determination was made of the actual amount of zinc chloride absorbed by each individual tie. Some ties were thoroughly air seasoned several months after treatment; others were used freshly treated. These ties were submerged in water for 24 hours and then dried for six days. They were again submerged for 24 hours and dried for six days, this procedure being carried on for several months. After each submersion the actual amount of zinc chloride which had leached out was determined.

The results show that the loss of preservative from leaching is about the same in the seasoned and freshly treated ties. The small excess of loss from the freshly treated ties is not of any great moment. The more important fact is that while the actual amount which has leached out from the two sets is very nearly the same, yet the manner in which this leaching took place is very different. The solution leached out of the freshly treated ties much more rapidly than from the winter seasoned ties. This may be explained as follows:

In the case of the freshly treated ties there was a direct water connection with the preservative in the wood so that practically all the zinc chloride leached out from the outside of the tie in a very short period of time. With the seasoned tie a very gradual leaching out took place from all parts of the tie. This would mean in the case of the freshly treated tie that the outside would very soon be unprotected, permitting decay to start, while in the seasoned tie a more uniform displacement of the salt takes place, insuring longer life.

The summer seasoned ties show a striking difference compared with the other two. The rate of leaching was very much reduced during the same period of soaking and the total amount actually leached out during a given period being very much less than for the other two series. The ties seasoned from October to May, the winter period, dried out very slowly and at the beginning of the test probably still contained considerable water in the wood cells while the ties seasoned from May to July, the summer period, dried out much more rapidly and more completely than the winter seasoned ties. These tests were made under extraordinarily severe conditions, and it is reasonable to assume that if these ties had been in track, the results probably would have been still more striking.

Checking of Zinc Treated Ties.—One of the results found by actual track inspection is that many zinc treated ties were taken out because of checking. The extent of checking varies with the climate, ballast conditions, and the kind of wood, and appears to be peculiar to zinc treated ties and does not prevail with creosoted ties.

General Reasons for Failure of Zinc Chloride Treated Ties.—As already indicated, zinc chloride treated ties have failed because (1) partially decayed or improperly seasoning before treatment; (2) improperly treated, either from excessive steaming, insufficient absorption of preservative, or unequal distribution of preservative throughout the tie; (3) poorly protected against mechanical wear; and (4) for lack of careful supervision of the entire process of treatment.

These factors have undoubtedly contributed much to the severe criticism of zinc chloride treatment.

Lack of proper mechanical protection stands out strongly as another reason for frequent failure of zinc chloride treated ties. While proper mechanical protection is essential on any treated ties, it is especially important on those treated with zinc chloride. Very slight mechanical abrasion or injury permits the preservative to leach out of the tie. Hundreds of thousands of zinc chloride treated ties have been removed from track in which the ends and middle were perfectly sound, but which failed immediately under the rail base.

Improper inspection and supervision of treatment is frequently responsible for the failure of zinc chloride treated ties. The solution is colorless and gives in itself no indication of its strength, nor is it easy to determine penetration by borings. Visual inspection of penetration is difficult, and more reliance must be placed on volumetric absorption. Slight errors in determining the strength of the solutions may have serious results. Zinc chloride treatment, furthermore, requires judgment of the conditions of the wood before treatment, and a complete appreciation of the many variable factors making for good treatment require technical inspection and supervision at all stages.

Contractors' Organizations and What They Can Accomplish*

By D. A. GARBER,

President of Associated General Contractors of America

Organization the Remedy for Unfair Contracts.—Nearly all of the contracts and specifications prepared for public works throughout the United States places all risks and responsibility upon the general contractor and are conspicuously one sided and unfair and in many cases have caused great and unnecessary loss to contractors.

The only remedy for these and many other evils that could be mentioned is organization. One of the chief concerns of The Associated General Contractors of America, which was organized last November in Chicago, is for the promotion of local, state or sectional associations of general contractors, since many of the reforms desired can only be secured through the concerted action on the part of the contractors concerned and the national body that co-ordinate the efforts of all local and sectional associations to realize those reforms.

Purposes of Contractors' Associations.—Associations of this kind should have high ideals as in accordance with the purposes set forth in your proposed constitution:

First: To promote better relations between private owners and public bodies, their architects and engineers on the one hand, and contractors on the other.

Second: To maintain high professional standards in the conduct of work.

Third: To combat unfair practices.

Fourth: To encourage efficiency among contractors.

Fifth: To support contractors and contractors' associations in efforts to rectify conditions of an unsatisfactory character.

Sixth: To encourage those methods of contracting for work which relieves the contractor of improper risks.

Seventh: To encourage sound business methods tending to raise the standing of contractors generally in the business world.

These are high and commendable ideals and if faithfully carried out will result unquestionably in great benefit to the contracting fraternity everywhere.

It should have a code of practice—an unwritten code, if you please—which would from this time on stop throat-cutting, which has been one of the faults of contractors in the past.

No honorable contractor objects to fair and legitimate competition, and no association or organization should be formed for the purpose of destroying fair competition, but the competition to which the average contractor has been subjected in the past is harmful to both owner and contractor. Unquestionably a proper code of practice would establish the contracting business in its rightful place.

There should be a committee also on mutual aid for the exchange of information concerning proper cost accounting, reliable estimating, fair and reasonable allowance for depreciation of plant conditions covering rentals and terms as applied to equipment. In fact, a general clearing house for the convenience and information of contractors generally. This association should also co-operate with all other associations which are formed for the betterment of business. They should be in close touch with the American Society of Civil Engineers, the Railroad Engineers and such other bodies as are interested in construction work generally. This association should protect its members against conditions arising from unfair legislation bidding conditions, specifications, plans, contracts, supervision and unfair labor conditions.

What Contractors' Associations Have Done in Securing Legislation.—In the matter of legislation alone the New York Contractors' Association has secured legislation at Albany which has been of great benefit to contractors generally throughout the state. In the last seven years they have had enacted 10 separate and distinct laws for the benefit of the contractors. These amendments are as follows:

Amendment to labor law, abolishing the penalty of cancellation of contract for violation of the 8-hour law.

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*[illegible] address March 26 before [illegible] Contractors, St. Paul, Minn.

[illegible] permitting aliens to be employed [illegible]. The penalty [illegible] cancellation of con[illegible].

A [illegible] withdraw their retained [illegible] by substituting securities of equal value to the amount withdrawn.

A [illegible] public works contractors per[illegible] contractors on public [illegible] April 6, 191[illegible], the [illegible] of the work when the cost was in excess of the contract price. This applied to all barge canal contracts, subway contracts and in fact all public works contractors in New York state.

The Rivers and Harbors Association, assisted somewhat by the Associated General Contractors of America, secured the passage of the relief bill, giving relief to rivers and harbors contractors. The Southwestern Ship Builders' Association is attempting to get relief for the builders of wooden ships; the Government Contractors' Association and the Associated General Contractors of America had introduced last session in the House and in the Senate bills for the relief of building contractors engaged upon Federal buildings throughout the United States, also had a relief measure inserted in the Public Building bill, and also in the General Deficiency bill, and would have obtained the relief had it not been for the filibustering of the Senate, which prevented the passage of all appropriation bills. These bills will be passed when they come up in special session, which we all hope will be soon called, and these contractors or many of them will be saved from bankruptcy.

Contractors and Business Men Should Oppose Immigration Bill.—This association also can use its influence not only in promoting legislation advantageous to contractors, but in defeating legislation that is detrimental to their interests and detrimental to the interests of the country at large.

The bill prohibiting immigration, introduced at the last session of Congress, should be contested by every contractor and other business man in the country. That is a bad and a vicious piece of legislation. There is a great demand for this bill, for they say we must keep out of this country the Bolshevism of the old world; we must keep ourselves free of them for four years, but it admits into this country the student, the musician, the artist and traveler. That is what that bill does; it prevents the entry into this country of the common laborer, the man who actually works here, who makes a good citizen and who is a constant worker. It keeps him away, and lets in that long-haired aggregation of students, which includes the agitator. It is the duty of every one of you as Americans to oppose that law because it is class legislation of the worst kind.

They will tell you that one of the great reasons why we don't want these people in this country is because the return of the soldiers is at hand and we want places for them. Now, as a matter of fact, the class of work that this class does is not now and never was and I hope never will be what the returned soldier has been doing and is not connected with that class of labor at all. Let it be done by this same class that has always done it before and has done it well. Now, I think your organization can do a great deal towards these relief bills.

Getting Construction Started.—The railroad contractors in this country have been called upon to stop work. Now, I believe the things we are all interested in is to get something started. We have been in a desperate condition and the country is in a bad condition now.

We have got to maintain that prices are more or less stable now. We know that labor is stable and is going to remain so more or less and possibly there will be an increase and the man that does the work is entitled to a legitimate wage, just as much so as we. He has the same heart and the same desires for home and family and for the luxuries of life that we have. That is right and proper. It isn't for us to discourage him, but there is another side to the thing. When you, either as agent or owner, pay him $10 when you used to pay him $5, all you ask of him is efficiency to a point of honesty that he shall give you back 100 per cent in labor for the additional money you give him. That is all you can ask. That is the situation of the labor proposition.

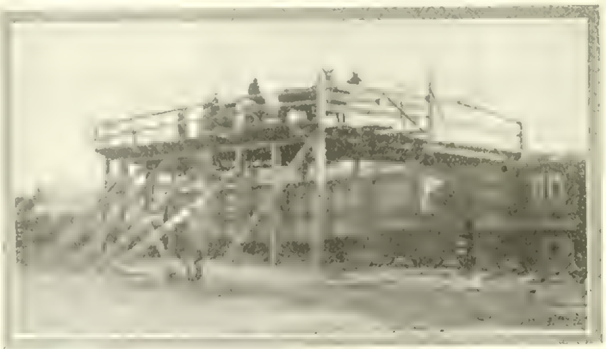
Men in your walk of life in order to study the labor situation and be more or less familiar with it must be friendly with your men, but try to increase efficiency wherever you can. Now, I hate the word efficiency, that is camouflage to talk about it the way it has been exploited in the past, but efficiency to the point of honesty and not to the point of exacting more from him than you pay him is all right and proper, for you should get from him exactly what you pay for, and then you are honest with him and he is honest with you and you will find there is no more trouble!

A Plan for Getting Building and Railway Construction Started. My idea about this thing is that an organization such as this and all other organizations as soon as the next Liberty Loan is out of the way, as soon as we re-convene Congress, which will be in the very near future, is to secure the passage of the omnibus bill, the public buildings bill. It will release $60,000,000 out into these jobs and it will let somebody get to work. It will also release another $33,000,000 now in the treasury department because of the fact that the appropriations were made on the basis of 1915 prices and are not sufficient for present day prices. That could be released in 10 days after the act. How the $60,000,000 would be handled was provided for in a clause empowering the Governnor, Secretary of Treasury and Mayor of a town to appoint one man each to form a board in the community in which these projects are to be built. Those men were to employ an architect to make the drawings immediately and the work let to a local firm wherever it could be done and not necessarily to the lowest. Immediately when the bill passes there will be 150 offices working on these projects instead of one office in Washington, and the whole $60,000,000 would be on the market in 60 days.

Now, the thing that interests you is the railroad problem. There can not be any prosperity in this country under the conditions as they exist today as far as the railroads are concerned. We must in some way start something so the proper officials of the railroads can go ahead with what improvements they so badly need. When I speak of we I mean the Government. In the past, instead of helping them to go ahead we have refused to appropriate the money. Then we fell out with the railroad officials as to how these charges ought to be apportioned, whether to the corporation or to the Railroad Administration, and the result has been that the railroad contractor in this country has been called upon to stop work.

Trap Loading with Dump Wagons

An interesting method of trap loading with Western dump wagons was employed by the Cook-O'Brien Construction Co. in the construction of an 8-mile railroad for the Cudahy Packing Co. for the development of silica beds near Fowler, Kans. The illustration, from the Earth Mover, shows the method of loading stripping material which was used for ballast. The elevation of the hill where the stripping took place was slightly above the level of the platform. In the platform was a trap door on hinges, so fastened that it could be tripped at will. The wagons from the elevating grader were driven successively to the platform and dumped upon the trap door without stopping the teams. After each load had been discharged the door was tripped, letting the material fall into the car below. Such an arrangement permits a free movement of the team and does not restrict the output of the elevating grader.



Trap Loading from Dump Wagons.

Effect of Curvature on Railway Maintenance of Way

Railway engineers in making surveys for new lines or for contemplated changes in old lines have desired accurate data as to the effect of curvature on maintenance, and for the most part have had to content themselves with rather unsatisfactory information. This has been due to the fact that many railroads have not until comparatively recent years kept records which would be of value in securing the desired data.

The Pennsylvania Lines West of Pittsburgh have recently furnished to the Committee on Economics of Railway Location of the American Railway Engineering Association some interesting data which were presented in the committee's report at the March convention.

Table I, from the committee report, gives data concerning rail renewals on straight and curved track on 164 miles of the Eastern Division of the P., Ft. W. & C. Ry. from Rochester to Crestline, for a period of 31 years.

TABLE I.

	Average length of track.	Length of track renewed in 31 years.	Number of renewals in 31 years.	Average life, years.	Ratio of renewals, tangent being equal to 1
Tangent	1,037,633	2,988,561	2.88	10.76	1.00
Curve ....0° to 1°	117,107	332,539	2.84	10.90	.99
Curve ....1° to 2°	157,323	510,289	3.24	9.57	1.12
Curve ....2° to 3°	79,847	267,823	3.35	9.25	1.16
Curve .... 3° to 4°	46,384	186,291	4.01	7.73	1.39
Curve .... 4° to 5°	34,819	153,764	4.42	7.04	1.53
Curve ....5° to 6°	4,580	24,146	5.27	5.90	1.82

On account of the physical characteristics of the portion of the road investigated there are no data covering curves over 6°. The information contained in Table I has been plotted graphically, and an effort has been made to plot a curve showing a fair average of the results obtained. (See Fig. 1.)

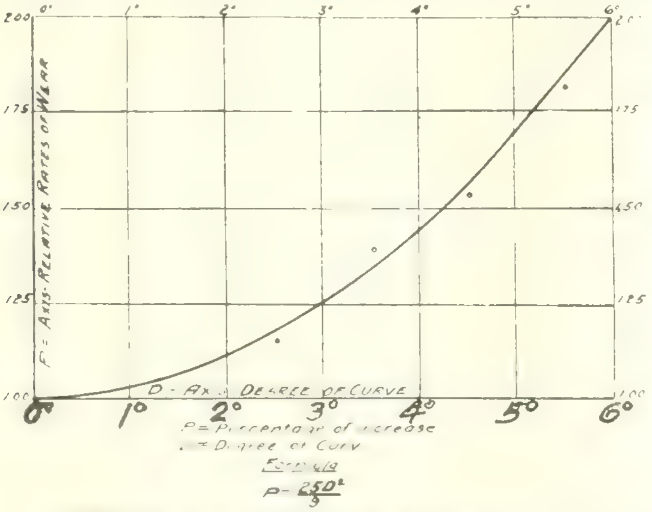


Fig. 1—Relation Between Wear of Rail on Straight Line as Compared with That on Curves.

Table II gives the length in miles and percentages of straight and curved track on the Pennsylvania Lines West for all main tracks.

TABLE II.

	Road		All tracks	
	Miles.	Per cent.	Miles.	Per cent.
Straight	[illegible]	80.9	3,365	78.4
Curves 2° and under	[illegible]	9.8	487	11.3
Curves over 2° and under 4°	[illegible]	6.1	286	6.6
Curves 4° and over	[illegible]	3.0	151	[illegible]
Total curved	[illegible]	19.1	924	21.5
Total straight and curved	[illegible]	100.0	4,289	100

The ratio of wear for different degrees of curve has been combined with the lengths and percentages of straight and curved track and these results are shown in Table III.

TABLE III.

No. of miles.		Ratio of wear.	Equivalent mile of straight track.
3,365	Straight	1.00	3,365
487	Curves 2° and under	1.10	[illegible]
286	Curves 4° and under	1.30	372
151	Curves over 4°	1.60	242
4,289		1.076	4,515

Table III indicates that the increased wear of rail due to curvature is about 7.6 per cent.

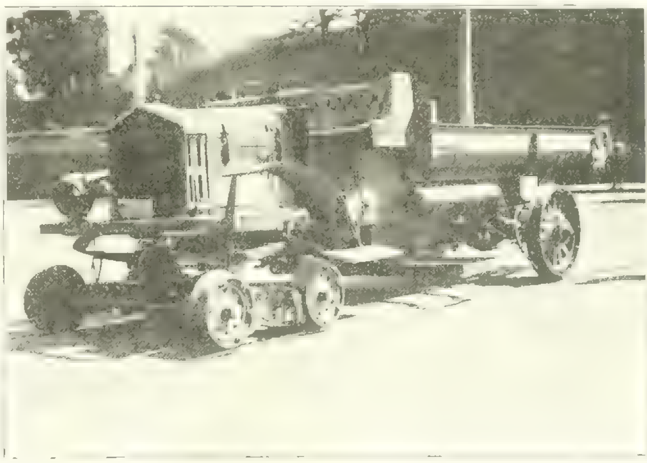
It would seem a fair assumption that other maintenance of way expenses due to curvature would increase in about the same proportion as that for renewals of rails, and that the expenses will vary on each part of the line according to the amount and degree of curve. The committee hopes that further investigations will determine the accuracy of this assumption.

The committee calls attention to the fact that the Pennsylvania data show that the average increase in rail wear on curves as compared with tangents, is about 100 per cent for a 6° curve, and 25 per cent for a 3° curve, or approximately as the square of the degree of curve. The value of this information is evident when it is remembered that heretofore it has been customary to estimate curve expense directly with the central angle, or with the degree of curve when a given length is considered.

Motor Truck Operated on Hetch Hetchy R. R.

Motor trucks equipped with flanged rear wheels and pony trucks in front are being successfully employed on the Hetch Hetchy R. R. for hauling express. This railroad, 68 miles in length, was built by San Francisco for conveying construction material for the Hetch Hetchy water supply project which the city is developing. Two Pierce Arrow 2-ton capacity trucks and one Packard 3-ton capacity truck are at present in use on the railroad. An interesting feature of these rail-trucks is the arrangement for turning them. This is done by means of a turntable permanently fastened underneath the chassis.

In order to facilitate operation, it is necessary that the turntable be located very accurately in the center of the weight, so that a perfect balancing effect is obtained after the rig is raised for turning. A regular 5-ton jack is used for this purpose.



Two-ton Pierce Arrow Truck Equipped for Operation on Railroad.

When it is necessary to turn the machine, the turntable is swung horizontal with the rails and one side is raised about 2 in. and blocked up; the jack is then removed to the other side and raised until the wheel flanges are clear—this side is then blocked up also, after which the jack is removed. If the turntable installation has been properly made, the driver will perform the whole operation in from 10 to 12 minutes.

The air sanders on the truck are operated from an 8-in. by 35-in. reservoir, charged by a 4-cylinder Kellogg pump, installed inside the engine hood.

The Hetch Hetchy development is being carried out under the direction of M. M. O'Shaughnessy, City Engineer of San Francisco.

314,936 Tractors Will Be Made in 1919, Manufacturers Estimate.—A production of 314,936 tractors in the United States in 1919 is estimated by manufacturers reporting to the Office of Farm Equipment Control, United States Department of Agriculture. The reports obtained in a special inquiry by the department show a production of 132,697 tractors in 1918. Of the 1919 production 157,671 will be of the 20 and 22 hp. size; 48,545 will have a rating of 16 and 18 hp.; 40,875 of 24 and 25 hp., and 27,465 of 27, 28, 30 and 32 hp.

MANAGEMENT AND OFFICE SYSTEM

This section is published twice a month: (1) In the Waterworks and Hydraulic Monthly issue, and (2) in the Railway and Excavation Monthly issue. It covers what may be broadly termed "management engineering" as applied in the civil engineering and construction fields.

Training Employes*

By E. A. Barnes

[illegible]

Reducing Labor Turnover.—While this turnover is estimated to cost [illegible] $[illegible] to $[illegible] per person, it is [illegible] attention. The loss [illegible] per placing of men [illegible] or attempting to continue them in work for which they are not particularly fitted or in which they are not satisfied. It is obvious, I believe, that the correction of this latter condition will not only contribute to the general efficiency of the plant but will be a strong influence in reducing labor turnover.

[illegible] have a real system of hiring, selecting, training, inspecting, and upgrading their help. In too many cases the old system of letting the shop foreman hire the men, without much consideration as to the applicants' ability and training, is still in effect, with the result that many of the new employes spoil work, ruin expensive machinery and tools, and really produce but little work that is perfect enough to be shipped. The "higher-ups" at such institutions, either through ignorance or fear, evince no interest in the working conditions of the men, but are satisfied to grumble and growl as a perfected system of bookkeeping brings enormous amounts of waste tickets to their attention month after month. The question, is the worker in the shop or office efficient, and, if not, why not? seems not to attract much attention. There are exceptions, however, to this general rule, for some few employers are now giving these questions the attention they merit.

Specialized Training Courses.—We conduct specialized training courses which may be divided into three groups.

First, the school for the graduate engineer. Here we give the young technical-college graduates an extensive course through the shops, laboratories, and testing departments, supplemented by lectures on special subjects.

Second, the apprentice school for machinists and toolmakers. In this school selected applicants are given a short preliminary course to see if they are likely to develop into efficient workmen. Those who pass this preliminary course sign a contract for four years (the time required for the completion of the course), during which the men are given one and one-quarter hours' daily instruction in such subjects as drafting, mathematics, and business English. The other hours of the day are spent at the machine or bench, where they are under the direction of experienced instructors. These apprentice students are paid a fair and graded rate during the entire time, and at the end of the course are given a bonus if they pass their school examinations, and still a second bonus if they pass their mechanical examinations. It takes no stretch of imagination to realize that men so trained in an atmosphere of intelligence and advancement can not fail to become the finest grade of high-class mechanics, foremen, and leaders.

Third, intensive specialized courses. We have also found it exceedingly profitable to give an intensive training course in drafting for women, who, on completion of the course, are transferred to regular drafting work in the engineering and drafting departments. Women clerks in the factory also are given the advantage of special courses in blue-print reading and factory routine, which familiarizes them with the product and systems to the extent that they can readily grasp situations and intelligently carry on the work.

In general, we are prepared to give to special classes of our employes intensive instruction in subjects pertaining to their daily work that a few years ago would have been thought wholly unnecessary.

Temporary Training Department.—Provision having been made for the training of the future engineers, special machinists, draftsmen, clerks, and future office executives it would seem that the training and upgrading of the man in the shop should be taken in hand and followed continuously and vigorously.

Our experience along this line extends over two years. When this country entered the war we were confronted with the common problem of obtaining adequate help to make up for the losses of young men entering the service, and were attracted by the bulletins put out by the U. S. Training Service concerning the vestibule school or training department. An investigation of some of the established schools developed the fact that they were in many respects similar to suggestions that we already had under consideration. We therefore decided to establish a real training department in which all classes of drill presses, grinders, engine lathes, turret lathes, and automatic screw machines would be installed, and where competent instructors would take applicants for employment and train them a sufficient length of time to guarantee their being productive when transferred to the factory. The rates to be paid the trained workers were attractive, and steady employment was insured.

We ran this school, training operators for machine work with great success until the armistice was signed, when the necessity for it in its initial form naturally ceased to exist. The reports from the foremen and manufacturing engineers in the factory indicated that the employes who had been trained in this vestibule school were very efficient and desirable help; these trained operators were, in fact, much sought after and competed for by our various manufacturing departments. These facts lead us to the conclusion that the systematic training system is a good thing, and that it should be installed permanently.

Permanent Training Department.—We have taken our instructors and are giving them a postgraduate course through the shops—a few days or a week, perhaps, in the automatic screw machine department, automatic bolt heading, in the special machine department where automatic wire bending and forming machines are installed, in the punch-press department, etc.—in order that these instructors shall know from actual experience the refinements and adjustments, speeds and conditions applying to all these machines.

With this training school in operation, it is our intention to refer to this school all newly engaged machine operators who can not furnish evidence of having served time or worked efficiently in a machine shop. In this school the capabilities of such new employes will be gaged before they are allowed to get into the shop proper.

"Instructors at Large."—Before we hire any more help we feel that our present employes should receive close attention and we propose to have "instructors at large," who are bright mechanics, going around the shop picking out operators who, due to lack of initial training, are less efficient than their neighbors. Such operators will be sent to the training department for a short period and will then be returned to their regular departments much improved, we believe, because they will have received individual, intensive training which they can not get in the shop itself.

In connection with this training department we expect to have classes in blue-print reading. Information will also be presented which will promote better relations between the employe and employer. Much of the general unrest that exists in shops today is brought about by the lack of appreciation of what the employer is doing, or would like to do, for the men. We feel sure that much benefit will be derived from an understanding of the situation that comes with practical demonstration. In other words, we will upgrade and educate our less fortunate employes, and in the hiring and selecting of new ones we will attempt to launch them into the factory world with a better knowledge of what is expected of them than has been possible in the past. There is nothing revolutionary about this scheme; it is simply a common-sense application to a worker on a special machine of what a modern apprenticeship system is to the more skilled mechanic.

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*[illegible] S. Training Service of the [illegible]

A Splendid Investment.—This systematic training may appear to be an exceedingly expensive enterprise in which only a few concerns can afford to embark. This is by no means the case. Our statisticians have shown us that it costs from $25 to $100 to train each employe. If, therefore, this system of scientific training enables us to cut our turnover in two, or even reduce it by one-quarter, the amount saved would be unbelievable.

A well-organized training department must of necessity work on production work that it needed in the shop, so, as a matter of fact, while you are training your mechanics and workers their output is being sold with profit. If business conditions should not warrant a continued hiring of new help, the training department, equipped as it is with modern machinery, can be used to advantage to test out applicants for better positions. It has been developed that as soon as some systematic training system it put into effect, operators who under ordinary conditions would be satisfied to stay on one particular job, become ambitious to advance, and if the opportunity is held out to them through the medium of these industrial engineer "instructors at large," etc., their applications for advancement and trial elsewhere can be given much better consideration. On the other hand, the foreman of the department is usually only interested in keeping his help so as not to have to break in new men. There is no doubt that contented employes can only be insured by giving them opportunities to advance, good pay, ideal surroundings, and thoughtful and humane employers.

[The United States Training Service will furnish free expert advice and guidance in forming training departments in any plant. The experts of the service are assigned to most of the big industrial centers between the Atlantic Coast and the Mississippi River. They are at the call of manufacturers who are considering the training of their employes as a stimulus to production and are seeking to minimize their labor turnover. Address all inquiries to Charles T. Clayton, Director United States Training Service, 618 17th St., Washington, D. C.]

Engineers as Intermediaries Between Labor and Capital

Discussing a paper on the "Use of Non-Financial Incentives in Industry" at the last annual convention of the American Society of Mechanical Engineers, Mr. A. L. De Leeuw said that the lasting growth of labor can only be caused by making labor grow from the inside out. The effort must be made by the laboring man, and not by the employer. The employer has only helped labor in general, but has not caused it to grow. Labor has taken the stand that it can grow only by antagonizing the employer, who, at one time, held this same view of labor. Something should be done to make labor start a growth or development of itself in the proper direction. If labor has not seen these facts, should not some one hold out the hand and invite labor to move in the right direction? Has not the time come, he asked, when the engineer should get in touch with labor and invite it to discuss labor questions from a standpoint of pure and simple engineering dropping all ideas of malice, and presenting the idea that a true bargain is one which benefits both parties? "Should there not be a third party," he said, "more or less disinterested, or rather, interested in the welfare of both, who will hold out the hand to labor and invite it to develop itself, to make an organic growth from the inside outward? Would it not be well if some engineering society were to invite labor into its counsel and see that a proper organized effort can be made for labor to look at the questions, not only of its own development, but of the development of industry as a whole, making labor to realize that no real benefits can ever come to it and be lasting unless similar benefits come to the industry as a whole?"

Saving Labor in Pay Roll Accounting

By using labor saving office appliances and systematizing methods a railroad effected a saving of $340 per month in handling the accounting for shops employing 4,500 men and having a monthly wage disbursement of $300,000 and material disbursement of $410,000. The system employed is described in the Railway Age to which we are indebted for the matter in this article.

As an experiment a calculating machine was secured for handling the daily time and materials tickets. A junior clerk was put to work on the machine and the results shortly justified the elimination of an $80 position and the employment of an experienced operator at $55 per month. The machine not only handled the above features, but also took care of all calculations, pro rata included.

The next move was to reduce the time put in on the payrolls. The average number of men handled by this department was 4,500. This meant that by "man power" it was necessary to write the name, occupation and check number of 4,500 men twice each month.

After casting about for some time the bright idea of an addressing machine was thought of. One was purchased, and in a test case, with an inexperienced operator, this machine in one hour and twenty-five minutes performed work that formerly consumed 50 man hours. The first move after employing a man is to make up a plate (from approved employment application) showing his name, occupation and check number. His service record card is then stamped; a loose leaf time record sheet is next stamped; the time sheet is stamped and the plate is then put in a plate cabinet in its proper place. Thus the name, occupation and check number is always the same on all records.

Payroll Machine.—The progress thus far made did not satisfy our chief accountant. He still felt there was room for improvement, especially on the pay-rolls. The purchase of a pay-roll machine was his next recommendation. Due to his previous success he had little trouble in getting a requisition through. It was necessary that some additional features be incorporated in the standard pay-roll machine in order to meet his requirements, and this was done, with the result that we now turn out our pay-rolls as indicated in the form shown.

As only the one central shop was using the addressing machine the standard form pay-roll sheet is used as it would not have been economy to make a new form to accommodate the one point. It will be noted that occupation is placed on the right of the sheet instead of on the left. The addressing machine takes care of the name, check number (which appears under the caption "line numbers") and the occupation. The pay-roll machine handles all other details on the form. The entire pay-roll is first run through the addressing machine, after which it is turned over to the pay-roll machine operator for listing the time.

The time-keepers close their time-books, the earnings being determined by use of regular rate tables and the figures appearing in the first four columns are those which have already been determined, but in putting these items through the listing machine the figures are checked; that is, the total items under the caption "items" are automatically derived and printed in the "total earned" column. Next the deductions are set in and the amounts are automatically deducted from the "total earned" and placed in either of the columns "amount due." If a time check has been issued the time check members are set in the "remark column," as shown on lines 3 and 5. By use of portable stops on the machine the carriage automatically travels from column to column. For example: The first figures in the column are set in, the lever pressed and the carriage moves to the second column, then to the upper portion of the third column, then it moves backward and up one line in order to put the figures in the lower part of column three, etc., until it reaches the end of the line, after which the carriage [illegible] travels back to column one. A few seconds to a line are all that is necessary, and after becoming acquainted with the machine the entries are made with much greater speed than by hand.

Attention is called to the special features of the machine which show by abbreviations, DA, CT and PW, meaning "days," "constructive time" and "piece work," respectively;

[illegible] and ½. These [illegible] the machine in [illegible] purpose. [illegible] is both ma[illegible] if these copies can be [illegible].

[illegible] of one [illegible] saving [illegible] needed to effect [illegible]

[illegible]

[illegible] for making plates and one cabinet for filing the plates.)

One half of the annual saving more than pays for the cost [illegible] in which the work is handled, the neatness, the elimination of errors [illegible] not only can the machines be used in the accounting department, but they can [illegible] other clerks in the same office.

The New Relations Between Manager and Employees

[illegible] article in the Scientific American, Mr. Mack M. Jones, Supervisor of Personnel of the Thomas A. Edison Industries, calls attention to the importance of developing a community of interest between the manager and the employes. He points out that the different phases of production and distribution group themselves around five "M's"—Men, Money, Material, Methods and Machines, and states that industries have grown up around a management which has emphasized these "M's" in varying degrees, and usually failed to balance them. He points out that the opportunities for constructive direction and control along the lines of one "M" alone—"Men"—afford opportunities for leadership that should challenge the genius of any financial power. He then goes on to say:

Are we to continue to be satisfied by purchasing the securities, clipping the coupons and deposting the proceeds or will we go further and inquire "how" and "why."

Scientific management ought to be viewed as "doing something the way it ought to be done." It should stand for balanced administration. In acually following out its principles we have analyzed and classified the more tangible of the industrial "M's" referred to above. Intensification of management, so far as it has applied to money, methods, materials and machines has been a process of analyzing and classifying that has brought great results and established the United States as the leading industrial nation of the world. Is it not time then, if we are using money, methods, materials and machines more scientifically and managing them more sensibly, to extend our energies further and take the other "M"—"Men"—applying the same experimentation, analysis, classification, etc., to it. Will the results not more than justify our action? It seems reasonable to suppose so.

The Manager Who Knows His Men.—One of the main problems in strengthening the industrial fabric of the United States is that of restoring the relationship between management and men that existed when industrial units were small and the manager knew all the joys and sorrows of each individual working for him. It of course may be out of the question to expect that the exact condition of acquaintanceship between the management and all of the men will be accomplished in fact, but it can be accomplished in effect. Through intensive organization can we not see that scientific methods are set up whereby the same intelligence is applied to transactions involving men as to all others?

Special emphasis should particularly be placed upon "will to serve," as the national efficiency today is low, and principally on account of the lack of a "will to serve"; not lack of "will to serve" the nation, but national ideals which call for doing well what is worth doing. More patience must be shown and more time spent in pointing out to men reasons why things are done.

Beating vs. Playing the Game. So far as "will to serve" is concerned, we have been accused of being far behind the average European nation. The joy of "a deed well done" is rather infrequent and almost a rarity. We have demanded so much speed that we have sacrificed accuracy and have been [illegible] basis. If we are to throw off the reputation of "dollar-chaser" we must stimulate the will to produce for the joy of producing and not subjugate the means to the end. We must have more of the spirit of "play the game" than "beat the game." Individual responsibility must be extended into the rank and file of the nation, and only by the finest kind of leadership can it be done.

Human relations determine the extent of realization upon an investment, and financial leadership determines the nature of the opportunity for the application of human energy. If investors therefore are not satisfied simply to have the results, but go further and insist upon having the results in a given way, a new era in management will be upon us.

You then who stand for or mold leadership will go one more step in advance if you will think, act and spread the following three ideas:

1. Develop "the will to serve" industrially.
2. Show that "what is worth doing is worth doing well."
3. Persuade men to "play the game" versus "beat the game."

Applying a Bonus System to an Office*

By WALTER D. FULLER,

Secretary, Curtis Publishing Co., Philadelphia

The need for encouraging high average workers to maintain their positions is obvious. If a bonus offer is to be truly successful, however, it is of even greater importance that the employee be raised to bonus earning ability, for until he reaches the production required for his guaranteed salary rate, he is an unduly expensive individual.

Peculiarly there seems to be a lack of comprehension of this need in many offices. Much pride is felt in the bonus earners, but little attention is given the less successful workers. Pride and the bonus furnish but slight stimulus to such workers. The cure comes through personal study and instruction, and through some sort of prize as an incentive.

Take for instance an office worker who is guaranteed a $12 weekly salary, but who, because her production of 2,000 instead of 3,200 units, is earning only $7.50—a loss to the establishment of $4.50. Before she can make any bonus she must increase her production by 1,200, which seems to ber almost impossible, unless she is encouraged and made to see how simple it really is. To this end we offer various forms of special prizes. One of the favorite methods is to offer a cash prize for each increase of 5 or 10 points in efficiency, over the clerk's best previous weekly average.

In the above instance the jump of 1,200 points before bonus earning commences might not seem worth the trouble, but where an offer of possibly $1 extra for a jump of 200 points is made, it is easier to get real effort from the worker. In such cases everyone gains.

One of the special values of this plan is that it gives the workers a "taste" of extra money and they usually move step by step into the bonus earning class. The offer is never withdrawn, but at about 100 per cent the possibility of further increase ceases.

This is a very simple example, but the same plan may easily be applied to more intricate bonus plans. The trouble with many schemes which start with small earnings at 66 per cent or 70 per cent is that the amount offered is so small that it is no real incentive at the time when it is most needed.

In brief, standardization work consists in revising conditions and methods after investigation, installing new methods, supervising the installation and doing whatever follow-up work may be necessary to insure efficiency. The actual permanent maintenance of the plan is handed over to the operating departments.

Let me review the advantages we secure through our corps of standardization specialists.

1. They insure uniform methods throughout the organization.

2. They bring in the valuable outside viewpoint without friction.

3. They spread information of methods and facts which have been found valuable in other departments.

4. They relieve managers of much detail which they have neither time nor inclination to attempt.

5. They centralize records of expense and results.

6. They centralize standardization in the hands of specialists.

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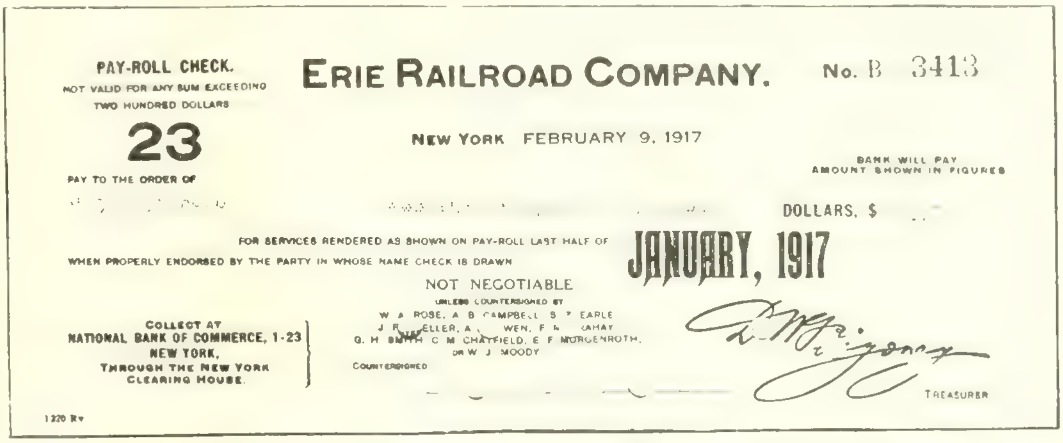
*From 100% Magazine.

Labor Saving in Pay Roll and Pay Check Writing

Payroll and check writing requires a large amount of time in railroad office practice. This work is of a very routine nature and on most railroads the writing, extending and checking of payroll figures are done several times. In order to eliminate duplicate work as much as possible the Erie R. R. has adopted a plan of writing payrolls and the checks in operation. This plan, which, by the way, could be used by contractors, is described in the Railway Review to which we are indebted for the matter that follows:

At the accounting bureau of the railroad approximately 12,000 payroll items and checks are written twice a month, which is done on three payroll and check writing machines. Previous to the installation of this bureau the payrolls were forwarded to the office of the auditor of disbursements, audited and then turned over to the payroll department in the general auditor's office. The checks were written by hand after hours by a force of clerks who received 70 ct. a hundred. Under the present arrangement the payroll and pay checks are written at the same time, thus saving the cost of writing checks, and amounts to an annual saving of approximately $2,000.


PAY-ROLL CHECK.
NOT VALID FOR ANY SUM EXCEEDING
TWO HUNDRED DOLLARS
23
PAY TO THE ORDER OF

ERIE RAILROAD COMPANY. No. B 3413

NEW YORK FEBRUARY 9, 1917

BANK WILL PAY
AMOUNT SHOWN IN FIGURES

DOLLARS, $

FOR SERVICES RENDERED AS SHOWN ON PAY-ROLL LAST HALF OF JANUARY, 1917
WHEN PROPERLY ENDORSED BY THE PARTY IN WHOSE NAME CHECK IS DRAWN

NOT NEGOTIABLE
UNLESS COUNTERSIGNED BY
W. A. ROSE, A. B. CAMPBELL, S. [illegible] EARLE
J. R. [illegible]ELLER, A. [illegible]WEN, F. [illegible] [illegible]AHAY
G. H. SMITH, C. M. CHATFIELD, E. F. MORGENROTH,
OR W. J. MOODY

COLLECT AT
NATIONAL BANK OF COMMERCE, 1-23
NEW YORK,
THROUGH THE NEW YORK
CLEARING HOUSE.

COUNTERSIGNED

TREASURER

1220 Rv

Erie R. R. Pay Check. Note That Payee's Name and Amount Are Both on One Line

A one-line check is written; that is to say, the payee and amount is written on the same line, thus saving time. The check is protected or safeguarded by the use of indenting type which cut the paper without mutilation and an acid proof ribbon is used.

In the various payroll bureaus, 14 Remington railroad accounting machines equipped for both vertical and cross adding are used, and they are entirely satisfactory in their operations. The operators each average 800 payroll items and checks in an eight-hour day. When the machines are not in use for payroll pay check writing they are used for the writing of vouchers and other matter.

The payroll is a form 17½ in. wide by 10 in. deep. Twelve columns are used, namely: "How employed, time rates, items, total earned, deductions, names, amount due, date paid, check number, remarks." As the items are written in the item column they are added in both the vertical and the cross totalizer of the machine. Each column is added vertically showing the total amount earned, total amuont deducted and the total amount due. When the total amount earned is written it accumulates in the vertical, but not in the cross totalizer. As the deductions are written they are subtracted through the cross totalizer, the latter now showing the amount due the employe. From here they are generally tabulated to the name column and at this point the check is fed into the machine. The name is written on the check, as well as on the payroll and the carbon copy. The amount due is written on the same line as the name, as the one line check is used.

Regular payroll checks are run in constant serial number and a separate series is used for substitute checks. Where the regular check is written incorrectly it is made void with red ink and the number of the substitute check written thereon. The regular check number is inserted on the substitute check, thereby accounting for all checks. In no instance is a check destroyed, and the first check number and last number indicate the number of checks written. When an error is made in the writing of the original check the correction is made on the payroll only, the number of the check being written as usual after the amount. The incorrectly written check is laid to one side and stamped "void" in red ink and the substitute number placed thereon. When the payroll sheet is completed the substitute check is filled in with the machine set at "disconnect," writing on platen roll, and the regular check number is written on the substitute check.

In view of the desire of the railroad administration that railroad employes be paid by check, the saving that can be effected by this method of pay check writing on all railroads in the United States is enormous.

An Excellent Plan for Handling Employee's Suggestions

The men employed in electric power plant of a large industry are encouraged to make suggestions which not only work to their benefit but prolong the life of equipment. So thorough is the belief in this policy that superintendents and foremen are instructed to consider seriously all suggestions from the men, even if they at first doubt the practicability of the suggested idea. There is more back of this policy than a mere desire to please the man who makes the suggestions. The idea may be good and the man may be entirely unable to put it into words. Even if the idea will not work, the company eventually gains because when the suggester has been shown that his idea is impracticable he is encouraged to find a way to remedy the condition which he has said can be improved.

The suggestion box system is different from the one ordinarily used, states the Electrical World, from which this note is taken. Suggestions are typewritten in duplicate and the originals are dropped in the boxes unsigned. When they are considered by the committee it is impossible for that body to tell whether it is handling an idea of the most skilled employe or of the newest helper in the shops. Each suggestion is considered on its merits. At the end of each six months all accepted suggestions are published in abstract so that the holders of the carbon copies can produce them and claim their awards of $2 to $100 for each idea, depending on the estimated value. This plan helps to fill the suggestion boxes. However, the biggest factor in bringing out ideas that will make equipment last longer is the company's policy of being liberal in trying out ideas.

Nine Laws of Industrial Organization.—In his paper, "Industrial Organization as It Affects Executives and Workers," presented at the last annual meeting of the American Society of Mechanical Engineers, Mr. Charles E. Knoeppel emphasizes the following points as being essential to the formulation of definite laws of organization: (1) The necessity of having an objective in the mind before beginning to work; (2) the exclusive concentration of each man to definite functions; (3) the avoidance of confusion and conflict of authorities; (4) the proper division of departments in order to insure that each executive has complete control of all the factors affecting the success of his function; (5) the creation of divisions which will develop specialists; (6) the provision for permanency by training men to fill the positions of their superiors; (7) the exact definition of the duties of each employe and of his relations to the others; (8) the logical selection of personnel according to individual qualifications; (9) and the creation of a standard manufacturing practice.

The Efficient Utilization of Labor in Railway Maintenance*

By W. [illegible]

[illegible] cuts and simplified operations. To unload this responsibility [illegible] they are completely occupied with seeing that existing standards are adhered to without evolving new ones. Nor can the result be attained all at once by those in higher authority "raw-hiding" the division engineers when instances are observed of too many men assigned to a job, of men bunched in surfacing or self-[illegible]

[illegible] methods of work and [illegible] to the whole railroad, and issued with authority just as a standard turnout plan is issued and the result of as careful, intelligent investigation [illegible] The scientific and analytical training of the engineer peculiarly adapts him for such work if supplemented by the practical experience of trackmen.

Factors Affecting Efficiency.—It is a common error to assume that each name on a payroll means a definite and fixed amount of work performed daily, and to confine our worries to the "shortage of labor." The fact is that more may be accomplished with a 50 per cent labor supply well supervised and using the best methods, than with a 150 per cent labor supply doing the work any old way, under mediocre foremen. Every variation of accomplishment from practically zero to nearly 100 per cent can generally be found among the track laborers on a sub-division depending on the following and other factors:

1. Ability of foreman, in
   (a) Planning work ahead
   (b) Short cuts or quick methods.
   (c) Placing the men while working.
   (d) Energy.
2. Incentive offered for accomplishment.
3. Type of labor furnished.
4. Feeding and housing.

The "type of labor furnished" is purposely placed near the foot of the list, as it is the firm belief of the writer that except for the very highest grade of native labor or the worst "bar-flies" the ability of the foreman is of greater relative importance than the grade of trackmen available.

It appears evident, therefore, that when maintenance engineers convene for mutual help, they will do well to devote time to planning how to organize to determine standard methods, and enforce them, for it is likely that the present labor shortage will become worse instead of better. The thing to do is clearly indicated—to shorten and simplify all manual operations, eliminate lost motion and all non-essentials, set standard methods and times based on these factors and finally to take steps to see that the recommended practices are followed. It is common at conventions and committee meetings to investigate and discuss technical matters like the coning of car wheels, the form of cut spikes, the chemical composition of wood preservatives, etc., all subjects doubtless of great importance, but it is hoped that some time will also be given to the consideration of how to utilize most fully the present restricted supply of labor by defining and standardizing methods of work and evolving short cuts.

Labor Wastes in Track Work.—In case anyone thinks the labor wastes in track work are insignificant, let him consider the following figures: Taking the ideal as 100 per cent, and assuming that an attainment of only 80 per cent is made owing to the over-assignment of men to different jobs, the result is 80 per cent. If a percentage of 75 is reached in the method of work the attainment now becomes 80x75, or 60 per cent. This will be reduced still further if there is no incentive. Suppose for lack of this stimulation the exact percentage is but 66⅔, then the dependent sequence becomes 80x75x66⅔, or 40 per cent final efficiency. The labor wastes are then 60 per cent, if the assumed percentages are correct (if anything they are too liberal, e. g., 75 per cent efficiency for "methods"), and if the operations are in sequence. In the following paragraph the subject is analyzed in units of men to show this sequence and to make the conclusion more apparent to those who wish to study it more thoroughly:

Suppose we have a gang of 10 men, in which the foreman has the common but unfortunate custom of assigning or allowing more men to the different operations than are necessary, e. g., when carrying ties a third man is allowed to walk along, taking hold of the tie; five men are sent with the hand car where four are sufficient; one man is permitted to stand and hold the tie up against the rail with a bar or shovel while tamping, which is an unnecessary measure if the spikes are settled before the tamping begins. The result of this practice in many gangs reduces the working force to 80 per cent of the original amount or to the equivalent of 8 men. These are all that are productively employed, and the fact that there are 10 on the roll and present does not alter this fact.

Next, as to the methods employed. We now have 8 men available. In nearly all operations there are short cuts and there are roundabout methods which result in reduced output. For instance, in clearing around yards, if the lumps of coal and the cinders are thrown over the bank with small shovels the work goes slowly; but if spike kegs, boxes or large shovels are used to carry and dump the debris, much faster progress is made. Again, when tamping, some men will stand and tamp until the ballast is driven out on the other side of the tie, if the foreman is not vigilant. Further, when unloading ballast, if the foreman assigns the men properly, sees that the catches on the pockets are free and explains what each man is to do, the work can go on rapidly; but if these things are not done the job will be unsatisfactory and slow, stone will be unloaded in heaps (to be moved later at considerable and unnecessary expense), and cars will be derailed. There are, therefore, great possibilities in good methods, predetermined and standardized, and to call the usual average 75 per cent is conservative. This means that but 75 per cent of the 8 men usefully employed are necessary or that the excess over 6 men are wasted.

The effective force is now the equivalent of 6 men. In the previous analysis the effort of the men, if working for day wages, was estimated to be but 66⅔ per cent, or two-thirds of what they will accomplish if working for pay in proportion to output. Therefore the output of the six men will be reduced to what four might perform if the latter are paid for accomplishment.

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*[illegible]

New Feeling of Labor Regarding Restricted Output.—In a discussion at the last annual meeting of the American Society Mechanical Engineers, Mr. Frank B. Gilbreth called attention to the changed conditions which were confronting industry with the close of the war. Where a soldier was returning to his former job, now held by someone whom he considered his inferior, he found that more work had been accomplished than he had been accustomed to do and that greater productive effort was to be required of him in the future. So true was this in Europe that it has resulted in the eliminations of all restrictions upon output. The realization has come that the salvation of the world lies in big outputs per man, said Mr. Gilbreth. Engineers and economists have known this for some time, but laborers have not. They have held an honest belief that restricted output was the one thing which assured every man his job. They are not going to believe this any more because the labor leader knows that it is not true. Further, the laborer will not only release all limitations upon output but he will use his craft and skill to increase output. The workingman's committee is operating in a number of places as yet unannounced and with remarkable results. They are not interfering with the management in obtaining intensive outputs but are working on such things as heating and ventilating, elimination of labor turnover, the selection of the right man for the right place, fatigue elimination, education and corporation schools.

Program of Work of Associated General Contractors of America

The purposes of the Associated General Contractors of America, organized last November, are set forth in the constitution as follows:

1. To promote better relations between private owners and public bodies, their architects and engineers on the one hand and contractors on the other.
2. To maintain high professional standards in the conduct of work.
3. To combat unfair practices.
4. To encourage efficiency among contractors.
5. To support contractors and contractors associations in efforts to rectify conditions of an unsatisfactory character.
6. To encourage those methods of contracting for work which relieve the contractor of improper risks.
7. To encourage sound business methods tending to raise the standing of contractors generally in the business world.

At a recent meeting of the executive board of the association Mr. G. W. Buchholz, acting secretary of the organization, submitted a report outlining the methods by which these purposes were to be accomplished. An abstract of his report follows: To carry out the work of the association 10 standing and 5 special committees have been created as follows: Standing Committees—Executive, Membership, Contracts, Legislative, Labor, Publicity and Education, Associated Organizations, Building Codes, Auditing, Mutual Aid. Special Committees—Cost Accounting, Finance, By-laws Revision, Ethics, Safety.

The first purpose of the association—the establishment of better relations between owners and contractors—is to be accomplished: (a) By convincing owners that the association stands for high ideals and that membership in the association guarantees the reputation of the contractor for skill, honesty and responsibility; (b) By establishing a uniform equitable contract; (c) By securing a more universal adoption of the cost plus sliding scale fee contract; (d) By persuading contractors that the interests of their clients and the community are identical with its own; (e); By treating employes with justice and liberality. This can be practiced by:

(a) Reducing lost time of men.
(b) Schooling our foremen.
(c) Encouraging apprenticeship.
(d) Reducing jurisdictional disputes.

The second purpose, the maintenance of high professional standards in the conduct of work, is to be accomplished by: (A) Making the association so universal, so powerful, that those who do not conform to its standards shall be outlawed, forced to reform, or seek some other industry; (B) By keeping in such close touch with the industry as a whole and making the association, its aims and purposes, so widely known that members or other general contractors will not dare to err; (c) By offering prizes for quality construction, original construction, etc.; (D) By using the association insignia on office doors, stationary and construction signs: (E) Proper advertising; (F) By assisting in the revision of building codes.

Unfair practices are to be combated by: (A) Moulding public opinion through propaganda and education; (B) Educating legislative bodies and public officials; (C) By conferring with other associations of architects, engineers and their clients and convincing them that their erring members should be disciplined; (D) By making the association universal enough, powerful enough, to hold employes within the bounds of reason; (E) By co-operation with National Association of Builders' Exchanges (representing sub-contractors); (F) By co-operation with National Material Dealers' Association to secure proper service, equitable prices and direct discounts.

Efficiency among contractors is to be encouraged by: (A) Exchange of information among our members; (B) By a system of studies and reports of committees or employes of the association, thus disseminating among members methods which have proved efficient; (C) By encouraging the adoption of safety methods and precautions; (D) By compiling a record of all competent and incompetent superintendents and foremen for the use of members. Also award appropriate association buttons to superintendents for every 5 years of service with members of this association; (E) By the study of equipment problems, their construction, improvement, maintenance, depreciation and rental; (F) By assisting in securing compensation insurance in the various states and urging the necessity of other insurance features; (G) By encouraging the use of progress diagrams and weekly summaries of costs.

The fifth purpose, rectifying conditions of an unsatisfactory character, is to be accomplished by: (A) Employing counsel to fight battles where the issue is of general interest; (B) By being able to discuss and adjust authoritatively such conditions with other national associations; (C) By watching legislation and the utterances of prominent or notorious men or bodies; (D) By co-operation with the United States Chamber of Commerce, National Federation of Construction Industries, National Highway Association, etc.

Encouragement of those methods of contracting for work which relieve the contractor of improper risks is to be carried out by: (A) Urging the adoption of the cost plus sliding scale fee contract where practicable; (B) By insisting that full information be given when lump sum bids are required; (C) By compelling the abandoning of the usual clauses putting up to the contractor all unforeseen risks and the clauses requiring the contractor to deliver a finished project regardless of what the architect or engineer forgot to specify or show; (D) By studying and possibly working out a practical arrangement for quantity surveys.

Encouragement of sound business methods tending to raise the standing of contractors generally in the business world is to be accomplished by; (A) Studying various systems of cost accounting, bookkeeping, estimating now in use, and making recommendations of the best methods for universal adoption; (B) By making general contractors appreciate that there is such a thing as overhead; (C) By arranging with auditing companies in various regions to employ field auditors experienced in construction work, by studying credits, fiancing, prompt system of payments and use of trade acceptances.

Concrete in Railway Track Construction

During the past few years engineers engaged in railroad maintenance have watched with concern the increasing speeds and enormously increased loads which the track has been called upon to sustain, and have sometimes wondered if the present type of track construction would not, at some not distant date, have to give way to something radically different. Inventors have from time to time worked with this idea in view and numerous substitutes for the present standard track construction have been presented to railroad officials. In the main, these suggested departures from the present standard have been honest attempts to provide a more nearly continuous support for the rail and to assure that this support should distribute the load safely to the soil, extend below the ordinary depth of frost, and eliminate the necessity for a deep bed of ballast to provide drainage, and in some cases to do away with the present wooden tie. But in all these improved (or different) forms of construction the railroad official has been but mildly interested on account of the invariably prohibitive expense of their adoption.

As is well known, some of the street railway companies in congested districts have used as a foundation under the ties a bed of lean concrete with good results; but the conditions are so unlike those under which steam railroads operate as to make any comparison of little value.

In several modern rapid transit and other railroad tunnels, special designs have been worked out, making use of concrete in the track construction.

A recent report of the Committee on Ballast of the American Railway Engineering Association contains information concerning some uses of reinforced concrete in track construction. The following instances are abstracted from this report:

The Southern Ry. has used a slab of concrete, either plain or reinforced, cast in place under a part or all of the track, where small soft places developed in the roadway in locations where the expense of draining them with tile to a suitable outlet would be very expensive. No forms were used for this slab of 2 or 3 ft. in thickness. The mix was comparatively lean, and the work was done by the section forces.

Experimental concrete slabs in which short ties are embedded were placed by the Northern Pacific R. R. on some new construction on a line just out of Tacoma, Wash., in 1914. Three types of slabs of varying cross sections were [illegible] to make records conclusive.

[illegible] R. R. on some special [illegible] during the winter of 1915 and 1916 [illegible] Terminal Improvement [illegible] of stone ballast [illegible] J. A. McCrea [illegible] commenting on this construction [illegible].

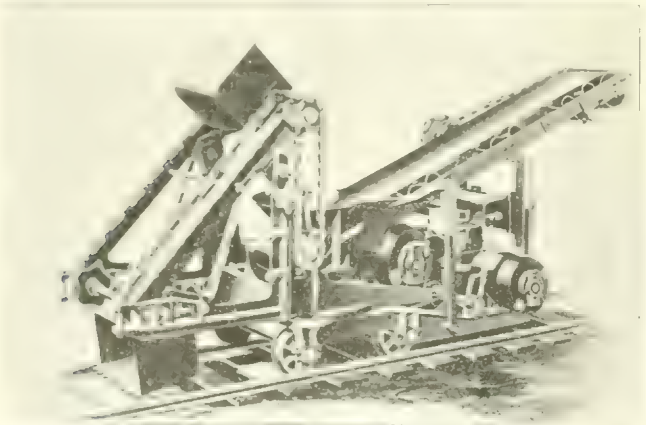
These [illegible] switches and [illegible] over [illegible] sq. ft. The embankment was composed of sand, and averaged 20 ft. [illegible] without allowing time [illegible]. The traffic has been [illegible] May, 1915 [illegible] per day. The switches are interlocked, electro-pneumatic system, and the signal department states that there has been practically no [illegible] of the rail that has caused them any trouble with the locking devices, and they attribute it to the presence of [illegible]. The maintenance department states that since the track was put in proper shape there has been practically no maintenance, after 3½ years' service. This is particularly noticeable in the frogs, which do not "rack" or loosen the bolts, and none have been replaced through this territory to date.

Concrete slabs are now used by several railroads under crossing frogs. As used by the Burlington R. R., the slab is 18 in. thick, reinforced, and extends 6 in. beyond the ends of the crossing frog ties. The top of the slab is either 4 in. or 6 in. below the bottom of the ties. Regular ballast is used. Just below the slab there are two feet of crushed rock, while drain tile at the base of this layer and leading to a nearby outlet takes care of the drainage.

The Ballast Committee in corresponding with chief engineers of many railroads found from the replies received two distinct ideas given considerable attention. First, that a concrete slab be used in which wooden blocks are embedded to which the rail is attached, and second, a thin concrete slab which would act as a division between the ballast and the earth roadbed.

Loading Machine for Underground Work

A loading machine, specially designed for underground work, has been placed on the market by the Wellman-Seaver-Morgan Co., Cleveland, O. This machine digs loose ore, dirt or muck by a continuous scooping process—the material being taken up by scoops or buckets on an endless chain elevated and dropped into a hopper which feeds to a conveyor belt which in turn loads into a car. The scooping mechanism is so pivoted that it can dig to the side as well as in front of the machine. The ore, however, being delivered to the conveyor through the hopper, reaches the car behind the loader no matter at what angle the scoop is working. The movement of the scoops is continuous—not reciprocating. The machine is self-propelled and is so dimensioned that it can easily be transferred around the mine. It is claimed that it will load at the rate of over a ton a minute and may be operated by unskilled labor. While designed particularly for underground work, the loader can also be used on the surface for loading coal from piles to cars, removing piles of rock and sand and similar operations. The loader is fitted with motors wound for 230 volts, D. C., providing power for all of the operations. The general dimensions of the loader are as follows:



McDermott Continuous Loading Machine.

Maximum overall length, 15 ft. 9 in.; Maximum height, 5 ft. 6¾ in. with buckets in lowest position; maximum overall height, [illegible] in., when machine is in operation; maximum overall width, 4 ft.; gauge of truck wheels, 24 in. Maximum rated capacity with full buckets is 1.75 tons per minute and the average rated capacity is 45 tons per hour. The weight of the complete machine is 8,000 lb.

Personals

J. B. Davidson, for the past 4 years professor of farm mechanics at the [illegible] of California, has been appointed head of the [illegible] department of Iowa State College.

George W. Snyder, assistant engineer maintenance of way on the Pennsylvania R. R., has been appointed to the newly created position of [illegible] storekeeper for the Pennsylvania Lines East, with headquarters at Philadelphia.

D. C. Fenstermaker has been appointed district engineer of the Chicago, Milwaukee & St. Paul R. R., with headquarters at Chicago, in charge of Iowa, Des Moines, Kansas City, Sioux City and Dakota and Dubuque Divisions.

Colonel W. Morris Chubb, corps of engineers, U. S. A., has been appointed to take charge of the Monongahela River by Division Engineer Colonel H. W. Stickle, relieving United States Engineer W. [illegible] Fairchild, who will report to Senior United States Engineer [illegible] W. Arras, in charge of locks and dams in the Ohio and Allegheny rivers.

G. W. T. Miller, formerly assistant engineer connected with the United States engineering office in Wilmington, Del., who was appointed several months ago to the United States engineer office in Baltimore, has been retransferred back to the Wilmington office as principal assistant engineer. He will have charge of the work of enlarging and rebuilding the Chesapeake and Delaware Canal under Colonel Jervey, United States engineer.

Obituaries

Edward B. Sturgis, lawyer, electric railway builder and coal operator, died April 8 at Scranton, Pa., aged 74. Mr. Sturgis was builder of the Suburban Street Railway of Scranton, said to be the first successful road of its kind in the country.

Col. James I. Baird, a well known engineer, died April 6 at Grand Rapids, Mich. Col. Baird had charge of the construction of the Monon R. R. before the Civil War. In 1882 Col. Baird moved to Chicago, where he built the Lake street elevated road, and also laid out many of the suburbs of the city.

Allen T. Fraser, of Winnipeg, chief engineer of the Canadian National Railways, was killed by a snowslide March 31 near Mount Robson, in the Yellow Head Pass through the Rockies. Mr. Fraser was appointed to the position of chief engineer on Jan. 1, and previously he had been district engineer of the C. N. R. and lived in Edmonton.

Charles E. Hoge, banker, contractor and manufacturer, died April 1 at Hot Springs, Ark., aged 74. As partner in the Mason-Hoge Co. he built a large part of the C. & O. system in Eastern Kentucky and West Virginia, now a part of the L. & N. system: the Frankfort & Cincinnati Railroad, from Paris to Frankfort, of which he became president, and many miles of the L. & N. system in Eastern Kentucky.

Industrial Notes

The Chicago Pneumatic Tool Co. has moved its Milwaukee office from Room 1305 Majestic Building, to Room 1118 in the same building, where more convenient quarters have been obtained.

F. V. Sargent has been appointed by the Chicago Pneumatic Tool Co. district manager of sales in the Boston territory with headquarters at 182 High street, Boston, Mass., succeeding F. S. Eggleston.

The Newhall Chain Forge & Iron Co., 90 West street, New York, recently completed and placed in operation a section of its new shop at Garwood, N. J., for the production of dredge, crane, steam shovel and foundry sling chains, special forgings, etc.

T. E. Doremus has been transferred to the E. I. Du Pont de Nemours Export Co. as general Eastern manager, with headquarters in Shanghai, China. E. R. Galvin has been appointed manager of the sporting powder division to succeed Mr. Doremus.

The Chicago Pneumatic Tool Co. announces the discontinuance of the office at Wichita, Kans., and the transfer of stock to Eldorado, Kans., where an office and warehouse have been established. The company also announces the opening of a new office at Tulsa, Oka., 313 Richards building, with warehouses at 102 North Cheyenne street.

Lieutenant Commander H. J. Elson, U. S. Naval Reserve Force, has been released to inactive status and has resumed his civilian work as secretary and treasury of Walter A. Zelnicker Supply Co., of St. Louis. He will have the general internal management of operations and manufacturing of the Zelnicker company and its various allied subsidiaries.

The Dayton-Dowd Co., Quincy, Ill., manufacturers of centrifugal and underwriters' fire pumps, announce the appointment of E. E. Maher as manager of the Chicago branch with offices at 30 N. Michigan boulevard. Mr. Maher was formerly western manager of the Lea-Courtenay Co. and more recently district manager for the Terry Steam Turbine Co.

The B. F. Sturtevant Co., Boston, Mass., has inaugurated a special course of training for its foremen in order to improve production and labor relations in its plant. A study group has been organized under John E. Calder, M. E., of the Business Training Corporation, New York, and E. B. Freeman, vice-president, at the factory, to take up a course in modern production methods.

The Sullivan Machinery Co. has recently organized a foreign trade department, with F. W. Copeland, formerly attached to the St. Louis office, as manager, with headquarters at Chicago. The purpose of this department will be to co-ordinate and assist the work of the foreign branches and agents of the company, and to devote the particular attention necessary to correspondence and inquiries from abroad.

Building and Structural Issue

ENGINEERING AND CONTRACTING

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The *articles* in the first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering and contracting field. The *articles* in the first and last issues of each month (1st and 4th Wednesdays) completely cover county engineering and highway engineering and contracting. The *articles* in the third and last issues of each month (3rd and 4th Wednesdays) completely cover steam and electric railway location, design and construction. See the "mast head" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellany

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation and Dredging
(b) Rivers and Canals
(c) Quarries and [illegible]
(d) Railway Steam and Electric
(e) Management and Office System

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials

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Volume LI. CHICAGO, ILL., APRIL 23, 1919. Number 17

An Employer Who Buys Books for His Employes and the Reason Why

The world war has to its credit an awakened appreciation of the possibilities of industrial education and training. It is probable that the entire cost of the war will be recouped in the next ten years by the increased efficiency of workmen. If so, no small part of this gain will be attributable to educational methods adopted by employers as a result of the success of the improvised schools for teaching and training war workers and military men.

May it not also come to pass that employers will not only provide industrial libraries for employes but will present a copy of any useful book to any employe who shows a desire to study and an aptitude at learning? Indicative of such a trend we quote the following from an article by Charles R. Wiers in "System":

"We purchase for an employe any book he wants which has been approved by a committee; the book remains our property until the employe, having read it twice, writes a brief accepted synopsis of it. Then we present it to the employe.

"For the first quarter of this year we bought, for 62 employes, 189 books. Some of these are duplicates; there were 86 different titles. Fiction predominated.

"It is difficult, of course, to determine the exact results we have gained from our educational work; but I think we may reasonably conclude, from the higher quality of work our employes do, that our investment has returned us a good dividend."

Mr. Wiers states that his company also offers to pay the entire cost of any educational course taken by any employe who has been with the company six months or more, provided the employe attains a scholarship record of 75 per cent. He says:

"Last year 44 of our employes enrolled for study under this plan at a total expenditure to the company of $400. Ten took up the study of English; five, typewriting and shorthand. Not all studied commercial subjects; our records show, among others, an enrollment of 14 in swimming classes, one in first aid, and one in public speaking.

In this connection it may be added that many railway companies make it a practice to subscribe for railway journals for their employes individually. This is far preferable to the older practice of merely supplying such periodicals through a library reading room. A

28 Pages = 40 pages

The 28 pages of articles in Engineering and Contracting contain as many words as 40 pages of the size and typography commonly used by other engineering periodicals. Ours is the same size of type and type-page as that of The Literary Digest—easily read, yet giving a large volume of reading matter per page. Our 28 pages of articles would fill 112 pages of the standard 6x9 in. text-book. It would take 10 such books of 580 pages each to hold all the articles printed each year in Engineering and Contracting, to say nothing of our weekly construction news.

[illegible] article is much more likely [illegible] who merely reads a borrowed copy. If the object is to educate the employe through reading, then a company may well afford to buy both books and magazines for the employes' personal use.

If stockholders in companies had an inkling of the really profound ignorance of most of their employes—ignorance [illegible] employes are presumed to be adept [illegible] that most stockholders would take? They would speedily insist that their directors and officials of their companies should waste no time in organizing classes of instruction. They would insist that the employes be provided with books and magazines for their personal use.

Editors of technical magazines are perhaps better qualified than any other class of men to state correctly the economic waste resulting from pure ignorance. Going, as we editors do, from place to place, and noting the obsolete methods and machines in common use, we would be daily amazed at the prevailing ignorance were we not calloused by long experience. We have come to regard it as inevitable that the average producer even in America is 20 years behind the times. It seems to take about a generation for a new economic method to permeate entirely through the mass of men, even with all our agencies for spreading knowledge.

Luther Burbank, in his great book, bemoans the general ignorance of horticulturalists and of farmers in general—an ignorance that makes the average cost of producing food fully double what it should be. We engineers read such a statement and pride ourselves that it applies only to "the uneducated"—to farmers and the like—little dreaming that it applies with equal force to the average man in every business or profession.

Ignorance and bad habits are the twin obstacles to progress. Whoever has the welfare of his fellow man at heart will do all that he can to reduce ignorance. Engineers in authority over other engineers should see to it that lack of engineering books and periodicals be not one of the bars to their progress. In general, all the "higherups" should lend a helping hand to the "lowerdowns," not merely by advice but by real educational service. Let it become the practice for companies and municipalities to furnish every worthy employe with the tools of education as well as with the tools of production.

How Long Will High Prices Last?

All long wars of modern times have resulted in a great rise in prices. This is known to most men, but it is not so well known that the price readjustments following every war have been spread over a long term of years. Our own Civil War of 1861-5 created an era of high prices that did not end till the panic of '73. In England the Crimean War brought about a rise in prices that persisted for ten years. The average of prices for the eight years preceding that war was 85, as compared with 122 for the ten years that followed it. In Russia prices average 103 for the ten years before the war with Japan and 130 for the seven years following the war.

More than a third of the world's stock of gold is now in America. Our currency has increased from $35 per capita prior to the world war to $55 at the present time. In the course of time much of our gold is likely to flow back to Europe; but who can tell how many years will pass before equilibrium is again restored? It is true that many emigrants have recently been leaving America, taking with them large quantities of gold. On the other hand, interest payments on our loans to our allies amount to nearly half a billion dollars annually. Much of our gold is apt to seek investment in Mexico and South America, but it will not go all at once. The movement of large amounts of capital into new fields is usually slow, because of the caution of capitalists.

There can be little doubt that the supply of gold in this country will remain abnormally large for many years. This will tend to keep prices up, particularly if a policy of protection instead of free trade is maintained. But the quantity of hard money is not the only factor to be considered in forecasting price levels. Far more important are the psychological factors. Here it is that political economists are apt to err. Prices would recede at once, in spite of the abundance of gold, if workers were to show a disposition to accept lower wages. But both in America where gold is more plentiful than ever and in England where it is less plentiful than it has been in many years, price levels remain abnormally high. Clearly, then, the determination of the wage earners to maintain high wages accounts for the high prices in both countries, the quantity of gold being a minor factor.

When the war ended, nearly six months ago, most men looked for a rapid drop in prices. Now the majority probably see that the drop will occur very slowly. At any rate, farmers are maintaining the prices of their staple produce, while manufacturers and merchants show a similar tendency.

After all, will it not be better for all concerned if we cease waiting for a fall in prices, adjust ourselves to the existing price level, and go ahead? The business men and farmers of America have apparently answered this question affirmatively.

The Fetish of Professionalism

Only within the last ten years have many civil engineers ceased to worship the fetish of professionalism. Even yet there are some who look down upon "commercialism," as they term anything that savors of business and lacks the professional taste. But the majority of civil engineers now regard engineering as being an amalgam of science and economics. Since business and economics have much in common, it follows that most engineers now regard themselves as part business man and part professional man. This is not the case, however, with the average architect, as is well brought out in an article in this issue by Oscar Wenderoth. Every engineer should read that article, "The Architect as a Business Man and His Relation to the Engineer," not only because it indicates a changing attitude toward professionalism on the part of architects, but because Mr. Wenderoth makes it very clear that architects and civil engineers must hereafter work in greater harmony and upon an equal plane.

Structural engineers employed by architects have long rebelled at being regarded as a "lower class," professional, it is true, but not quite so professional as an architect. In turn, the engineer has been inclined to look down upon the contractor because he is still less professional or not professional at all. And all this has happened because of a false theory of relative human merit, a theory that is traceable to the ancient reverence for the gentleman aristocrat, coupled with ill concealed contempt of the plebeian shopkeeper. Why have the "middle classes" of Europe aspired to educating their sons to be professional men? Mainly because they thus hoped to lift them into a caste one notch higher. The professional man had to earn his living, it is true, but by as far as he was able to escape the appearance of being a money grabber he was supposed to be nearer the nobility and farther from the trades people.

In spite of our American ideals of democracy, we have never ceased to worship the European fetish of professionalism. We still have a lingering feeling that there is something demeaning about money making; we are prone to regard it as a necessary evil. If not, why does the average architect think that to be an artist is preferable to being an economic designer—a structural engineer? If not, why does a structural engineer regard a building contractor as a lower order of being? If not, why have our engineering societies so long looked askance at any activities partaking in the least of "commercialism"?

Is there anything disgraceful about saving or making money? One might think so, judging by the attitude of the worshipers of professionalism. "I will not commercialize my profession," said the architect, and forthwith began to lose "patrons" who became "clients" of structural engineers and "customers" of contractors. Now many architects are urging the commercializing of their profession, pointing to the precedents established by engineers. There is a growing feeling that it is as respectable to earn or save money as to spend it.

Examination for Assistant Highway Engineers.—The State Department of Highways of Tennessee will conduct an examination for engineers, at Nashville, Tenn., on May 7, 1919, to qualify assistant highway engineers for the construction and reconstruction of roads under State and Federal supervision in the State of Tennessee. Any engineer from any State in the Union who is a citizen may take this examination, which is conducted by the Examining Board, as provided for in the general road law of Tennessee of 1917. From the register of eligibles resulting from this examination there will be selected employes to serve under the State Highway Department's direction in the conduct of its work.

Book Reviews

Steel Railway Bridges: Designs and Weights. By Edward C. Dilworth, Assoc. Mem. Am. Soc. C. E., Designing and Contracting Engineer, Pittsburgh-Des Moines Steel Co., formerly Designing Engineer, American Bridge Co. With 105 full-page plates. New York: D. Van Nostrand Co.

REVIEWED BY J. C. PENN,
Assistant Professor of Structural Engineering, Armour Institute of Technology.

Those who do not have access to shipping weights and the data on weights of structures such as large fabricating plants should have, will find this work of greatest use. Its aim as expressed by the preface, to supply practical data for the design and weight of steel for railway bridges, has been fully realized.

The first 14 pages are devoted to general dimensions, details of design and designing methods of the various parts of the structures. Centrifugal force, and clearances occupy another chapter. Some general notes on draw-spans, power required and their machinery, and turntables, cover some 8 pages. Detailing, presented in a way that appeals to one who has seen the usual hodgepodge in text books on structural steel, covers some 25 pages.

The remainder of the book, some 120 pages, is devoted to weight curves illustrated by three or four complete designs, giving stresses, sections of members, depth of girders and trusses, clearances, lateral bracing and nearly all of the assumptions and practical computations necessary for a complete design. Problems that are unusual are elucidated in the accompanying text. All kinds of railway structures are covered, except arches, cantilevers and suspension bridges. Both single and double-track structures are included; all designs are for Cooper's E40, E50 and E60, and all are according to our American Railway Engineering Association Specifications of 1912. The latter are quoted in full.

The author has succeded in determining a general formula that takes in the span, the type of bridge and the specifications for which the bridge has been designed. It is evidently an empirical formula derived from the weight curves themselves, although it derivation is not stated. Curves for the three loadings are given under each type, for the spans usually built under that type.

The author has succeeded in giving rational figures for the weight of steel. He is to be complimented on sticking to the aim of the book, in his ability to eliminate all outside matters and avoid the usual padding of a book.

There is no doubt that a student would turn more often to a book of this type for help in the drafting room than to his own text book, yet this book cannot be considered as taking the place of any text book.

Instructors will find it a veritable mine of information for the assignment of problems.

Concrete Engineers' Handbook: Data for the Design and Construction of Plain and Reinforced Concrete Structures. By Geo. A. Hool, S. B., Professor of Structural Engineering, the University of Wisconsin, and Nathan C. Johnson, M. M. E., Consulting Concrete Engineer. New York City, assisted by S. C. Hollister, B. S., Research Engineer, Corrugated Bar Co.; with chapters by Harvey Whipple, Adelbert P. Mills, Walter S. Edge, A. G. Hillberg and Leslie H. Allen. New York: McGraw-Hill Book Co., Inc. London: Hill Publishing Co., Ltd. Cloth; 6x9 in.; pp. [illegible]; illustrated. $5.

REVIEWED BY J. C. PENN,
Assistant Professor of Structural Engineering, Armour Institute of Technology.

In placing this book before the public the authors have thoroughly demonstrated their ability "to make available in concise form the best of present day knowledge concerning concrete and reinforced concrete and to present complete data and details, as well as numerous tables and diagrams for the design and construction of the principal types of concrete structures."

The volume is in no sense a reprint of Hool's "Reinforced Concrete Construction." Many subjects have been condensed or elaborated; many new subjects have been added and some entirely reconsidered by specialists in their lines.

The book can hardly be considered a text book, but students can find in it in addition to what their texts contain, all that is available on the subject and that information in concise form.

The book is divided into 19 sections, each subdivided into numbered articles. The contents of the books are fairly indicated by the sections as follows: (1) Materials; (2) general methods of construction; (3) construction plant; (4) concrete floors and floor surfaces, sidewalks and pavements; (5) properties of cement, mortar and plain concrete; (6) general properties of reinforced concrete; (7) beams and slabs; (8) columns; (9) bending and direct stress; (10) moments in rigid building frames; (11) buildings; (12) foundations; (13) retaining walls; (14) slab and girder bridges; (15) concrete floors and abutments for steel bridges; (16) arches; (17) hydraulic structures; (18) miscellaneous structures, including deep grain bins, silos, shallow bins and chimneys, and (19) estimating. The appendix contains specifications, working stresses, the latest flat slab rulings of various cities, standard notation and a paper on concrete barges and ships.

Section 5 is not over-burdened with results of tests. References are given, and concise, definite conclusions are derived from the results.

The section on moments in rigid building frames is not as satisfactory as it might be, and yet it is probably the best available. The stresses in rigid frames bring up memories of complicated mathematics based on various assumptions that may or may not be correct. With as little mathematics as possible, using the slab deflection method, formulas for moment and shear for a variety of rigid frames are deduced. Various style of roof and L frames are included.

Flat slab construction is handled in a very able way, many of the common commercial types being illustrated and many extensive tables being given. The Chicago and Pittsburgh flat slab rulings are quoted in full.

Under the subject of dams, arch dams, spillways, overflow dams, sluices, siphon spillways, as well as the preliminary studies, the foundations and effects of uplift are treated in a clear and concise manner. The problem of dome analysis is illustrated by an actual example.

Under arches, the method as given in Hool's original book is followed, as well as Cochrane's paper almost in its original form on the design by the elastic theory. Form work and centering are well illustrated.

The drawings are not always as clear as they might be, either because of too small lettering on the original or too much reducing. The use of various sizes of type to bring out the various degrees of importance of subject matter is to be commended.

Johnson's Materials of Construction. Rewritten by M. O. Withey, Associate Professor of Mechanics in the University of Wisconsin, and James Aston, Metallurgist with the A. M. Byers Co. of Pittsburgh. Edited by F. E. Turneaure, Dean of the College of Engineering of the University of Wisconsin. Fifth edition. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. 829; illustrated. Price $6.

REVIEWED BY J. C. PENN,
Assistant Professor of Structural Engineering, Armour Institute of Technology.

The materials of construction, their variations and their diversified applications have become so numerous since Johnson wrote his great work, 22 years ago, that it becomes a question whether all desirable information can be boiled down and contained in less than 1,000 pages. Yet the authors, each in his own line, under the direction of F. E. Turneaure, have succeeded in making the new edition an up-to-date, thorough book of reference.

The greater part of the book is written by M. O. Withey. Six chapters on iron and steel, their production and constitution, are written by J. Aston; fatigue of metals is treated by J. B. Kommers, and erosion of iron and steel by O. P. Watts. The collaborators have used good judgment in the selection of results of tests and data, and their application.

Applied mechanics, testing machines, and testing procedure occupy some 140 pages.

About 137 pages are devoted to wood, and 30 pages to stone and clay products. Cement and concrete, including lime and natural cement, spread over 220 pages. Metals, non-ferrous metals, cast iron, iron, steel and its alloys and properties require 230 pages. Three chapters on Effects of Temperature on Mechanical Properties, Fatigue of Metals, and Corrosion of Metal, respectively, close the book.

The data on cement and concrete, iron and steel are accumulating very rapidly, and the staggering amount of material on hand has been thoroughly combed by the authors, [illegible] handy volume [illegible] of alloys, the com[illegible] of steel, macroscopic [illegible] the specialist, but Johnson's "Materials of Construction," contains enough of [illegible] topics to be of value [illegible]

[illegible] adopted by the [illegible] Materials and Abram's Fine[illegible] Method for Proportioning Concrete.

[illegible] contain opinions that may differ from the accepted ideas. They merely emphasize the fact that our knowledge of the disputed point needs further elaboration. As an example, their opinion on the value of the tensile test of cement may upset some pet ideas, yet their reasoning is clear and obvious.

Value and Construction Uses of Non-Metallic Mineral Products

[illegible] products produced in 1916, according to statistics compiled by the U. S. Geological Survey, [illegible] It is interesting to note that clay and clay [illegible] surpassed in value among all mineral products only by coal and iron. The value of other nonmetallic mineral [illegible] were:

	Total Value
[illegible]	$1[illegible]
[illegible]	8[illegible]
[illegible]	30,[illegible]
[illegible]	11,000,000
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	2,200,[illegible]
[illegible]	2,000,000
[illegible]	1,660,000
[illegible]	670,000
[illegible]	8[illegible]
[illegible]	120,000

The following tabulations from the March, 1919, bulletin on mineral investigations of the U. S. Bureau of Mines shows the industrial uses of the above mentioned products, the estimates being based on the 1916 figures:

[illegible] SAND AND GRAVEL, CLAY, CHALK, GYP[illegible] AND SOAPSTONE, ASBESTOS, MICA, MAG[illegible] FLUORSPAR, ABRASIVES AND FULLER'S EARTH

[illegible] consuming industries [illegible] in order of value of mineral products	Percentage of total value. (Estimate only)
1. Structures relating to land and water transportation, including bridges, roads, streets, sidewalks, rail[illegible] subways, dams, canals, river and harbor work (including breakwaters, dry [illegible] and wharves) concrete [illegible] parts of all ships	31
2. Private building enterprises, including dwellings, farm buildings, apartment houses, stores, theaters, churches, warehouses, factories, gas and electric light plants, etc.	27
[illegible] postoffices, court houses, schools and colleges, libraries, museums and other federal, state and municipal buildings, fortifications, filtration plants, water distribution systems, sewage [illegible]	1[illegible]
4. Mining and metallurgical industries, including mines, ore dressing plants, smelters, refineries, foundries, rolling mills, lime and cement plants	11
[illegible]	[illegible]
6. Monumental industries	1.7
7. Chemical industries	0.4
[illegible]	0.3
9. Oil industries	0.2
10. Motor and aerial transportation	...
General consumption (the relative importance of this group is uncertain).	

Strength of Scratched and Smooth Glued Joints.—The common assertion that scratched surfaces make stronger glued joints than smooth surfaces seems hard to prove. Comparative tests made on several occasions by the Forest Products Laboratory all indicate that the strengths of these two types of joints are practically the same. The test specimens used by the laboratory were pairs of hard maple blocks, some with smooth and some with tooth-planed contact surfaces. These blocks were glued with a high-grade hide glue, allowed to stand for a week, and then sheared apart in an Olsen universal testing machine. Four joints of each type were compared in a single test. For 11 such tests the general average shear strength for scratched joints was 1,988 lb. per square inch; for smooth joints the general average shear strength was 2,040 lb. per square inch. In seven of the eleven tests smooth surfaces gave the better adhesion. It would seem that there is no advantage in tooth-planing wood for gluing purposes.

Cost Plus Fee Contract for Bridge Construction

Excellent competition under a cost plus a fee form of contract was obtained at a bridge letting in Kansas City, Mo., last month. The work called for the construction of the 23d St. viaduct, a reinforced concrete and steel girder structure, requiring approximately 19,000 cu. yd. of concrete, 900 tons of steel, 1,000 tons of reinforcing metal and 13,000 sq. yd. of pavement. The contract, prepared by Harrington, Howard & Ash, Kansas City, Mo., Consulting Engineers for the bridge, provides that in case the actual cost overruns the estimated cost the contractor loses one-half of the excess up to a maximum loss of two-thirds of his profit fee; in case the actual cost is less than the estimated cost the contractor receives one-half of the saving. It also provides a method for correcting the contractor's estimated cost in case the quantities in the structure vary.

Bids for the work were opened March 11. The following is a summary of the bids received for constructing the viaduct, including paving with wood blocks. Bids also were taken for paving with brick and bitulithic:

Contractor	Contractor's est. cost, using wood block paving.	Profit fee asked	Total.
A. S. Hecker Co.	$681,000	$50,000	$ 731,000
Arkansas Bridge Co.	679,560	60,000	739,560
Edward B. Garretson Co.	681,440	61,329	742,769
Mellan-Stuart-Nelson Co.	695,000	50,000	745,000
Missouri Valley B. & I. Co.	686,000	67,000	753,000
Hunkin-Conkey Constr. Co.	756,861	40,000	796,861
Koss Construction Co.	739,000	70,000	809,000
J. O. Petterson & Co.	795,000	78,000	873,000
A. Guthrie & Co.	813,300	60,000	873,300
Fraser, Brace & Co.	925,406	80,000	1,025,406
Foundation Co.	986,214	60,000	1,048,214

Extracts from the form of contract follow:

Bids are to be on a "cost plus a fee basis" as set forth in the contract. Each bidder shall state his estimated "cost of the work," which shall be termed Contractor's Estimated Cost, and shall also state a fee which shall be termed Contractor's Profit Fee, which shall be separate from and not a part of the Contractor's Estimated Cost. The Contractor's Profit Fee must not exceed 10 per cent of the Contractor's Estimated Cost.

The Contractor's Estimated Cost shall be assumed to be based upon the approximate quantities stated in the contract. Inasmuch as the actual quantities in the finished structure may vary from these approximate quantities, each bidder must also quote unit prices for each of the various construction items as given in the form of proposal and bid herewith. These unit prices shall be applied to the differences between the approximate quantities given and the actual quantities in the completed structure. The sums so obtained shall be added to or subtracted from the Contractor's Estimated Cost accordingly as the actual quantities are respectively greater or less than the corresponding approximate quantities, thus fixing an amount to be termed the Revised Contractor's Estimated Cost. (See Clause 2 of contract concerning Profit Fee.)

2. MODIFICATIONS OF PROFIT FEE.

The contractor shall be paid in cash in the manner hereinafter provided, the Actual Cost of the Work plus a Profit Fee. If the Actual Cost of the Work is equal to the Revised Contractor's Estimated Cost, the contractor shall be paid the Contractor's Profit Fee in full. If the Actual Cost of the Work is less than the Revised Contractor's Estimated Cost the contractor shall be paid the Contractor's Profit Fee, and in addition thereto, one-half of the amount which the Actual Cost of the Work is less than the Revised Contractor's Estimated Cost. If the Actual Cost of the Work is more than the Revised Contractor's Estimated Cost, the contractor will be paid the Contractor's Profit Fee less one-half of the amount which the Actual Cost of the Work is in excess of the Revised Contractor's Estimated Cost; but in no event shall the contractor be paid less than the Actual Cost of the Work, plus one-third of the Contractor's Profit Fee.

3. ACTUAL COST OF WORK.

The Actual Cost of the Work shall include such of the actual net expenditures of the contractor in the performance of the work as may be approved or ratified by the engineers and as are included in the following items:

(a) Wages and salaries paid laborers, mechanics, watchmen, general foreman, bookkeepers, instrument men, foremen, timekeepers, auditor, stock clerks and other employees, actually engaged on the work, and team hire; the number and qualifications of each to be determined by the engineers.

(b) Materials and supplies, including fuel, oil and power, hand tools not owned by the workmen, equipment for plant (such as timbers in derricks, lines for hoisting engines, pipes and hose for air tools), and tools wholly or partially consumed on the work.

(c) Building and equipment for necessary field office and the cost of maintaining and operating said office, including incidental expenses, such as telegrams, telephone service, expressage and postage.

(d) Rental on plant and equipment supplied for the work at 3 per cent of its value per month for the calendar months, or parts thereof from its installation at the site until its removal is directed or authorized by the engineers; the cost of unloading the plant and equipment at the site of reloading it for shipment upon completion of the work; the freight on the plant and equipment from its present position to the site of the work (but not return freight upon the plant and equipment from the site of the work to its origin). Whenever the total rental paid for any element of plant shall equal 50 per cent of the value of such element on which the rental is based no additional rental will be paid for such element but it shall be continued on the work as much longer as desired, rent free.

(e) Permit fees, royalties, premiums on insurance, including public and employer's liability, fire and oher insurance, and such losses and expenses not covered by insurance or otherwise, as are found by the engineers to have been actually sustained by the contractor, in connection with the work, and to have clearly resulted from causes other than the fault or neglect of the contractor.

(f) Transportation and legitimate expenses involved in procuring and bringing labor, mechanics or other employes to the work and in expediting the production and transportation of material and equipment; freight and other transportation charges (but not transportation or traveling expenses of contractor's executive officers or general superintendent in charge of the work).

(g) Such other items of expense as should, in the opinion of the engineers, be included in the cost of the work. When such an item is allowed by the engineers, it shall be specifically certified as being allowed under this paragraph.

4. PROFIT FEE.

Tho profit fee paid to the contractor shall be deemed to cover and include the contractor's profit, the use of his organization, his skill and energy, overhead expenses, administrative expenses, services of contractors' executives giving occasional attention to work, services of the general superintendent devoting all his time to the work, all contractor's legal expenses, interest on moneys used, taxes, all expenses of any office or offices of the contractor other than the field office on the work, maintenance and repair of the plant items he furnishes, and all other expenses deemed by the engineers not a part of the actual cost of work as herein defined.

PLANT

The contractor shall furnish at such times as the engineers may direct or approve all plant and equipment considered by the engineers necessary or desirable for the conduct of the work. Plant shall be defined as boilers, hoisting engines, pumps, air compressors, locomotives, dump cars, rails and splices for railway tracks, concrete mixers, concrete hoists and chutes, clam shell and other buckets, derrick irons, iron fittings for travelers, electric motors, electric controllers and transformers, electric or air drills, electric or air hammers, engineers' levels and transits, electric or steam hoists, locomotive cranes, power saws, power operated tools, wagons, bottom dump wagons, wheel scrapers and slips, motor trucks, and such other plant and equipment which, in the opinion of the engineers, is of similar character. All such plant and equipment shall be delivered at the site complete with all necessary parts and attachments in sound and workable condition ready to be operated. (Plant is not expected to be delivered equipped with lines for hoist engines, hose for pumps and air tools, wiring for electrical machinery, and similar plant accessories, except that conveyors or similar equipment shall be complete with wire ropes.)

When such plant and equipment or any part thereof, shall arrive at the site of the work, the contractor shall file with the engineers a schedule setting forth the fair valuation at that time of each part of such construction plant. Any evidence of such valuation, required by the engineers, shall be furnished and such valuation shall be deemed final unless the engineers shall, within ten days after the plant and equipment have been installed and are working, modify or change such valuation, in which event the valuation so fixed by the engineers shall be deemed final.

Plant and equipment shall be delivered to the site of the work at times, which may be approved by the engineers and rental will be paid for the plant and equipment from the date of unloading, if required to be immediately installed, or from the date of installation authorized, until its removal is authorized by the engineers.

The contractor shall, at his own expense, maintain all plant elements on which rental is paid, in good operating condition, and shall replace broken parts or elements consumed. All costs incident to the operation of plant shall be paid as part of the actual cost of the work, but costs incident to the maintenance or repair or replacing broken or defective parts shall be considered as covered in the rental allowance for plant, and shall be paid for by the contractor. In case of plant damaged or destroyed by accident not incident to the operation of the plant and not the fault of the contractor, but due to unusual and unforeseen causes, the restoration and repair of the plant elements on which rental is being paid, if the engineers so direct, be included as part of the actual cost of the work.

6. WAGES—MATERIALS—PRICES.

Tho wages paid for labor and the prices for material shall not exceed the usual prevailing prices for labor and material of the kind and character paid in Kansas City, Mo., without the prior consent and approval of the engineers. All materials and supplies shall be purchased upon prior requisitions approved by the engineers. Unless otherwise approved by the engineers purchases shall be made after competitive prices are received by the contractor, which must be as low as those generally prevailing in Kansas City, Mo. The contractor shall furnish to the engineers schedules of the materials necessary for the work from time to time and shall submit the prices at which the contractor can purchase such materials. Purchase shall be made after approval by the engineers unless the city through the engineers, should secure other lower and more satisfactory prices for the given schedule of materials.

7. SALE OF MATERIALS.

Upon the completion of the work all materials, supplies, tools and elements which have been included under actual cost of the work and which are not entirely consumed, shall be sold or disposed of as directed by the engineers, and the amounts derived from such salvage value shall be applied to a reduction of the actual cost of the work.

The contractor will be held responsible for a proper accounting of all such materials, supplies, tools and elements, and will be charged for any which cannot be produced or be shown to have been wholly or partly consumed in the work. The parts of broken tools and other such elements as may be consumed in the work shall be produced at the end of the job or at intervals throughout the job so that they may be certified off by the engineers. Immediate disposition shall be made of any such items certified off at times prior to the end of the work by sale or otherwise, as may be directed. Tools or other elements so destroyed, lost or missing from the work as to make impracticable the presentation of broken parts shall be accounted for by suitable affidavit made at the time of such destruction.

10. PAYMENTS.

On or about the first day of the month the contractor shall prepare a statement showing the amounts which he has expended for labor and materials including the rentals of the plant, during the previous month (which had been previously ordered and approved by the engineers); such statement shall be accompanied by signed pay rolls and receipted bills, or other evidence that payments have been made for all of the expenditures represented. The engineers shall verify such statement and, if found correct, shall render estimates to the city covering the total amount of such statements, or so much thereof as may be found correct. Payments in cash in the manner hereinafter provided will be made upon the engineers' estimates about fifteen days after they are rendered. The engineers' decisions shall govern as to what items shall be and what shall not be included in the estimate under the cost of the work as provided herein. The estimate shall show the total gross amount of expenditures to date, the expenditures for the month past, and the previously allowed payments. The total amount of the estimate, less previous payments, shall be paid to the contractor in cash.

Effect of Colors on Tensile Strength of Concrete.—The results of a series of tests made to determine the effect of the various commercial colors used in concrete work upon the tensile strength of portland cement, are given by Mr. O. R. Smith, Testing Engineer, in a recent issue of Concrete. Usual cement testing procedure was followed in all the tests, the test pieces being aged in water. Ten per cent of the color was used in each case except the black, of which only 5 per cent was used. The results given in the table below are in each case the average of three tests.

Age.		No adidtion	Brown	Red	Black	Yellow	Buff
			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	100	70	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	115	[illegible]	[illegible]	[illegible]	[illegible]

The setting time of the cement with the various additions of the color was nearly normal in every case excepting where the black color was used. This caused the cement to set very quickly. The permanence of the color was also noted, at each period, by comparing it with the color of test pieces made out of the same batch, but allowed to age in moist air. No change of color was apparent.

A Simple Method for Designing Concrete Beams Reinforced for Compression

BY ARTHUR RAYMOND

[illegible] double-reinforced concrete beams [illegible] cumbersome and difficult [illegible]. As the result of this many diagrams and tables have been [illegible] to curtail the mathematical [illegible]. The writer is always ready to avail himself of aids and helps of all kinds to facilitate designing. In his experience, he has found there is one serious objection in using these "short-cuts" and that is, in not bearing in mind the limits between which they apply and beyond which they do not. [illegible] concrete beams are reinforced for tension only and when it is necessary to reinforce them for compression it is, because, as a rule, of complying with some practical considerations in the structure. Many times such a beam is a very important member in the structure and some care should be given to its design.

For example, recently the writer had in connection with the design of a club house of reinforced concrete construction, a girder of 40-ft. span in the auditorium above the stage. Two columns from the story above came at about the third points of this girder in addition to the floor load. As the depth of this girder was limited in order to give the required head room at the stage, and the loads and span being large, the concrete could not take all the compression and compression steel had to be used. So in this particular case, the girder was a very important member and had to be carefully designed.

The following is the general theory covering this matter. The student of this subject will note that some approximations have been made, but they are all on the safe side and what the writer particularly wishes to emphasize is the clearness and practicability of this method. The notation used was:

a'_s = cross-sectional area of compressive steel.
a_s = cross-sectional area of tensile steel.
f_s' = unit compressive stress in steel.
M = bending moment in [illegible].
T = total tension.
C = total compression.
c' = compression taken care of by the concrete.
c'' = compression taken care of by steel.

The other notation is that commonly used in reinforced concrete design.

Case 1: Rectangular Beams.—Having found the bending Moment M, we have,

$$T = C = \frac{M \times 12}{jd}$$

Concrete takes care of

$$C' = \frac{kd\,b\,f_c}{2} \quad \text{(See Figs. 1 and 2)}$$

$C - C' = c''$. The compression to be taken care of by steel

$$f'_s = nf_c\left(\frac{kd - z}{kd}\right)$$

Then

$$a'_s = \frac{c''}{f'_s}$$

$$a_s = \frac{T}{f_s}$$

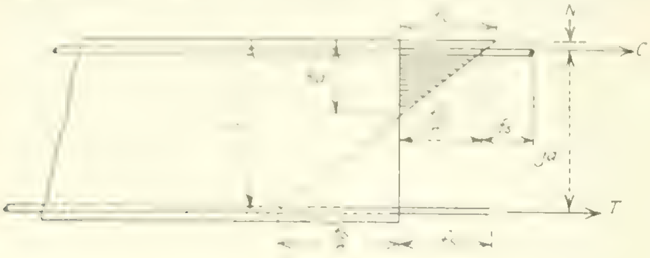

Fig. 1

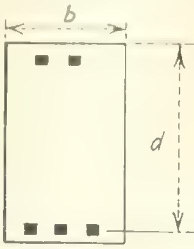

Fig. 2

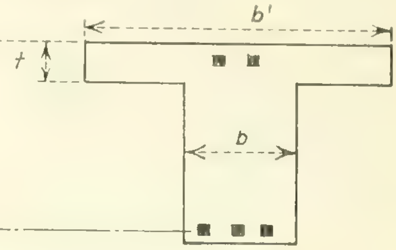

Fig. 3

Figs. 1, 2 and 3.

Case 2: Tee Beams. The method here is similar and applies to beams that have not a sufficient tee, in order to develop the tension steel, therefore, compression steel is needed. Again

$$T = C = \frac{M \times 12}{jd}$$

Here j will vary, depending upon ratio of $\frac{t}{d}$ and unit stresses used. Where ratio $\frac{t}{d}$ is very small and the neutral axis naturally falls well down in the stem of the beam, j can be easily obtained from a table or a diagram that is found in every office, using $\frac{t}{d}$ and the unit stresses as arguments. When the neutral axis falls near the tee or in the tee, the beam can be treated as in CASE 1.

The concrete takes care of the following compression:

(1) Stem of beam $\frac{kd\,b\,f}{2}$

(2) Tee of beam $= (b' - b)\,tf'_c$ (see figure 3)

Where f'_c = average compressive stress of the concrete in the tee of beam; f'_c can be found at same time as j or can be readily computed as follows:

Let f_{c_1} = compressive stress in concrete at distance t from top of beam

$$f_{c_1} = f_c\left(\frac{kd - t}{kd}\right)$$

$$\text{Then } f'_c = \frac{f_{c_1} + f_c}{2}$$

Adding (1) and (2) we obtain c',

The remainder of the method is the same as in Case 1.

Illustrative Problem.—Given a beam whose cross-section is limited to 10 in. x 24 in. and which is to sustain a bending moment of 800,000 in. lb., $n = 15$ $f_c = 650$ lb. per square inch and $f_s = 16{,}000$ lb. per square inch. Both the tensile and compressive reinforcement is to be placed at 2 in. from the respective surfaces of the beam:

$M = 800{,}000$ in. lb.

$$T = C = \frac{M \times 12}{jd} = \frac{800{,}000}{.874 \times 22} = 41{,}600 \text{ lb.}$$

$$c' = \frac{kd\,b\,fc}{2} = \frac{378 \times 22 \times 10 \times 650}{2} = 27{,}000 \text{ lb.}$$

$$C - c' = 41{,}600 - 27{,}000 = 14{,}600 \text{ lb.} = c''$$

$$f'_s = nf\left(\frac{kd\text{-}z}{kd}\right) = (15)\,(650)\left[\frac{(.378)\,(22) - 2}{(.378)\,(22)}\right]$$

$f'_s = 7{,}420$ lb. per square inch.

$$\text{Then } a'_s = \frac{14{,}600}{7{,}420} = 1.97 \text{ sq. in.}$$

$$\text{Then } a_s = \frac{41{,}600}{16{,}000} = 2.60 \text{ sq. in.}$$

Fabricated Shop Capacity Contracted for in March.—The records of the Bridge Builders and Structural Society, as collected by its Secretary, show that during the month of March, 1918, 17½ per cent of the entire capacity of the bridge and structural shops of the country was contracted for.

Strength of Hollow Building Tile

A final report on an investigation of the strength in compression of hollow building tile has been issued as Technologic Paper No. 120 of the Bureau of Standards. The tiles used in these tests were manufactured in the state of Ohio and supplied to the Pittsburgh Branch of the Bureau by the National Fire Proofing Co.

Although originally used for their fire-resisting qualities, other advantages have extended the usefulness of tiles to a great extent. They may be briefly stated as follows:

(1) It requires comparatively less labor in construction, as the space occupied by one tile is quite large; (2) it is relatively impervious to moisture; (3) it possesses good heat-insulating qualities; (4) it effects a saving in clay compared to solid brick because of the hollow cells of the tiles and a consequent reduction in the cost of transportation; (5) it possesses good fire-resisting properties; (6) it is a poor conductor of sound; and (7) it has sufficient strength to meet the needs of building practice under the limitations of adequate specifications. Of these several advantages the paper is limited to a discussion of the one pertaining to the strength of the tiles.

The temperature of burning, although moderate, the several degrees of porosity, caused either by burning at different temperatures or by admixture of coal dust or sawdust before molding, the properties of the clays used, the degree of burning, the position in kilns when burning,* all enter into the strength in compression. Although the position in the kiln, and to some extent this is a measure of the temperature at which the tile has been burned, can be judged by the color of the product, yet the natural color of some clays or the presence of coloring matter will cause a variation. In general the high-burned tiles are dark in color, the medium-burned of medium shade, and the low-burned light.

Very porous tile is light in weight and a splendid fire re-

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*Changes in the amount of pressure to which clay is subjected while being molded.

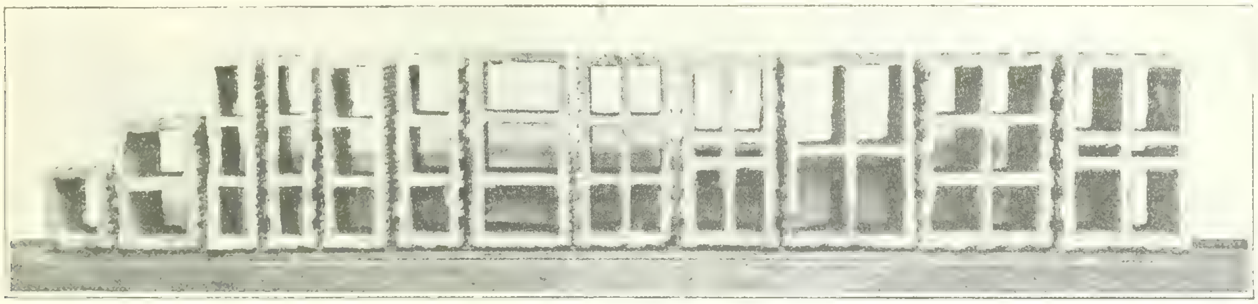

Fig. 1.—Tiles (from left to right) 4 by 5 by 12 in.; 5 by 8 by 12 in.; 3 by 12 by 12 in., type 1; 3 by 12 by 12 in., type 2; 4 by 12 by 12 in., type; 4 by 12 by 12 in., type 2; 6 by 12 by 12 in., type 1; 6 by 12 by 12 in., type 2; 6 by 12 by 12 in., type 3; 8 by 12 by 12 in., type 1; 8 by 12 by 12 in., type 2; 8 by 12 In. ,tpye 3.

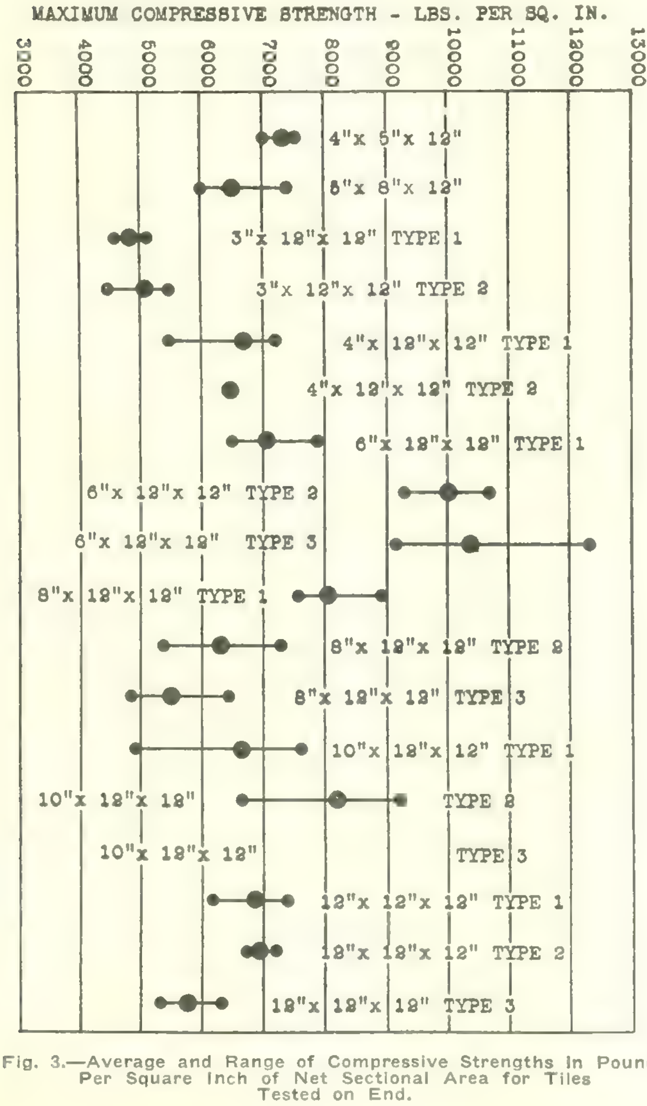

Fig. 3.—Average and Range of Compressive Strengths in Pounds Per Square Inch of Net Sectional Area for Tiles Tested on End.

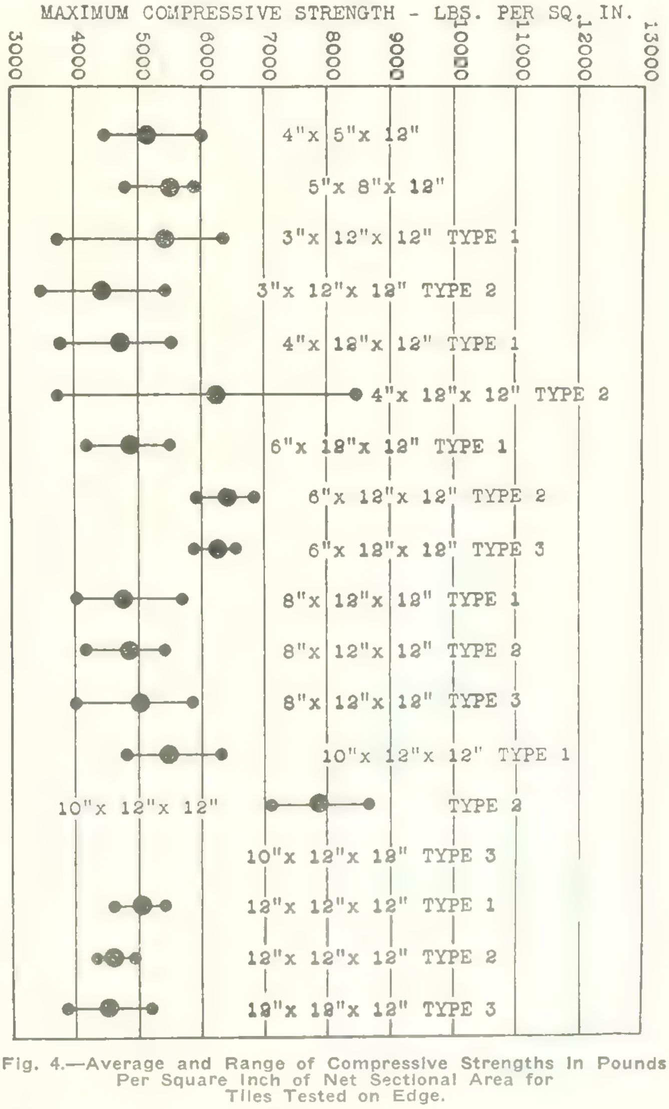

Fig. 4.—Average and Range of Compressive Strengths in Pounds Per Square Inch of Net Sectional Area for Tiles Tested on Edge.

[illegible] is of minor consideration. [illegible] tile is much heavier and [illegible] exterior walls where strength is [illegible].

[illegible] approximately 250 [illegible] tiles by compression. Stress-[illegible] of these for moduli of elasticity determinations. To establish the relationship existing between the strength and porosity about 70 absorption [illegible] taken from tiles previously tested in compression.

The various sizes and types of tiles tested, arranged according to their structure, are shown in Figs. 1 and 2 in which all the tiles are lying on edge. Also the tiles were graded according to their color as dark, medium or light, correspond[illegible] as described in the introduction. The tiles tested were made with few exceptions from clay of the buff-burning variety and the colors given above indicate variations in the buff color; that is, they correspond respectively to dark buff, medium buff, and light buff.

Previous to the actual testing, the tiles were capped with plaster of Paris to insure a uniform bearing in the testing machine. Plugs were also set in the tiles for compressometer readings.

No strain readings were taken in tests where the maximum height of the specimen was less than 10 in., but where the specimen was 10 in. or more in height strain readings were taken with the 8-in. Berry gage, beginning with an initial load of 100 lb. per square inch of net sectional area and continued at increments of 500 lb. per square inch until failure was approached.

Three pieces were selected from each tile upon which the absorption determination was desired. Two of the three pieces were taken from opposite ends of the specimen and from different webs, and one from the middle portion. The pieces were approximately square and ranged from 12 to 20 sq. in. area of face and were free from cracks or fissures from the breaking in the compression test.

The average weight per cubic foot of the constituent material of the tiles tested was determined to be approximately 124 lb. by using the net sectional area, the length, and the weight as the basis for the computations. The maximum variations from this average were 116 and 135 lb., or 6.5 and 8.9 per cent, respectively.

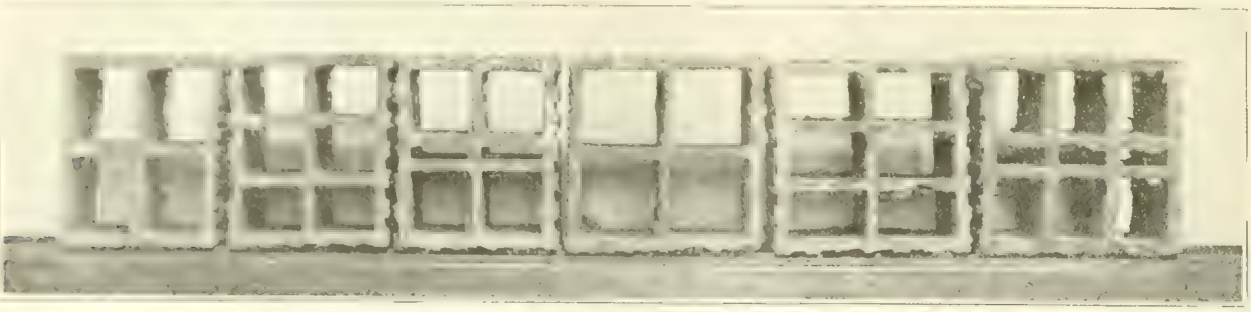

Fig. 2.—Tiles (from left to right) 10 by 12 by 12 in., type 1; 10 by 12 by 12 in., type 2; 10 by 12 by 12 in., type 3; 12 by 12 by 12 in., type 1; 12 by 12 by 12 in., type 2; 12 by 12 by 12 in., type 3.

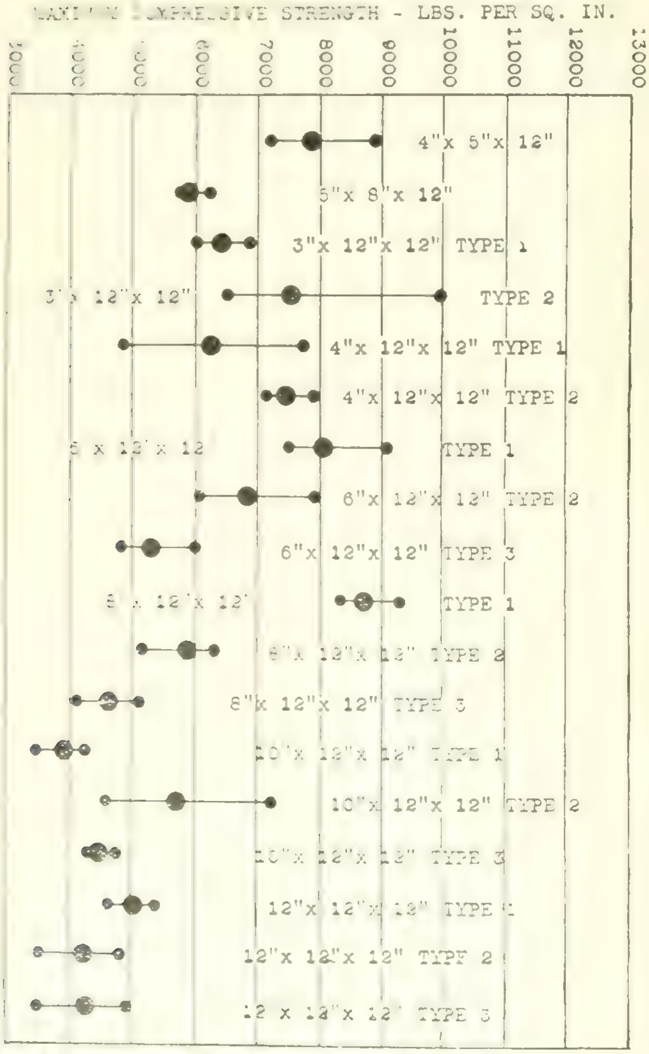

Fig. 5.—Average and Range of Compressive Strength in Pounds Per Square Inch for Net Sectional Area of Tiles Tested Flat.

The variations in weight depend on the same factors that determine the strength, although not necessarily proportionally.

Figures 3, 4 and 5 give the average maximum strengths and the range in compression of every size and type of tile tested. Size and type are illustrated in Figs. 1 and 2. A typical stress strain curve is given in Fig. 6. It is evident that the strain is approximately a linear function of the applied load.

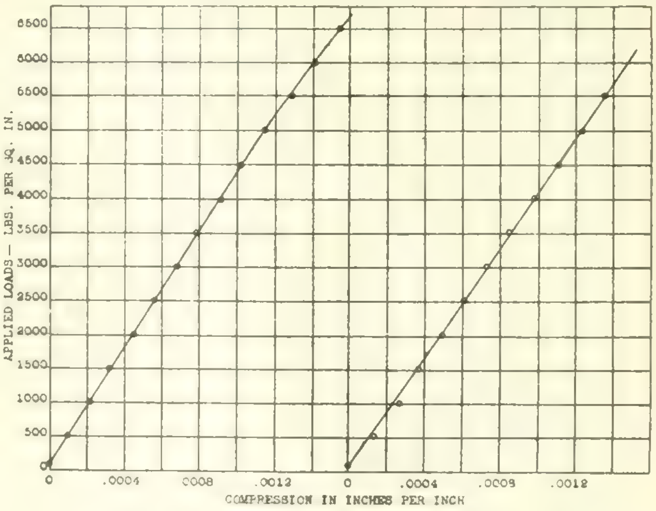

Fig. 6.—Representative Stress-Strain Curves of Tiles.

Although some of the smaller sizes gave greater strengths when tested on flat, yet since the smaller sizes are rarely used in this position, the general statement can be made that all types develop the greater strength on end than in any other useful position.

It is common practice to lay tiles either on end or on edge in a building, but according to the results of this series of tests, excepting size 4 by 5 by 12 in., it appears that an average of about 40 per cent more strength can be developed by laying the tiles on end rather than on edge; that is, by buildings all walls and other structures in such a manner that the load is applied to the tiles parallel to the flues or cells. The variations from this average are large and the strengths range from equality to a ratio of nearly three.

Based on tests on end, the following shows the relation between the compressive strength of tiles and their colors:

COMPRESSIVE STRENGTH IN POUNDS PER SQUARE INCH.

Color.	Average.	Range.
Dark buff	7,510	4,650-10,700
Medium buff	7,400	4,500-12,300
Light buff	5,530	4,820-7,500

The results indicate that the dark and the medium-burned tiles are of nearly the same strength, while the light-burned tiles average 25 to 30 per cent lower. A similar relation holds between the modulus of elasticity, the average for dark buff being 4,519,000, for medium buff 4,352,000, for light buff 3,074,000.

The relation between absorption and compressive strength cannot be expressed as a general law, but there is a tendency for the maximum compressive strength to vary inversely with the percentage of absorption. In general, too, the darker tiles show lower percentages of absorption.

The conclusions derived from the test of the particular tiles tested are quoted in full. It should be borne in mind that conditions in practice are quite different from those of the laboratory, that there are many grades and varieties of tiles, and that there are wide variations in the strength properties shown by tiles which are apparently similar.

1. The weight of the tiles per cubic unit varies greatly with the porosity of the constituent material.

2. The porosity of the constituent material of tiles is dependent upon the clays used, the percentage of sawdust mixed with the clay before burning, the pressure to which it is subjected during molding, and the degree of burning.

3. The color of the same tile material is subject to change during the burning process, and the resulting tiles may vary in color from very light to very dark shades, depending upon the temperature reached and the time of burning.

4. The strain produced by loading a tile is approximately a linear function of the applied load until failure is reached, or, in other words, the modulus of elasticity of a tile is nearly constant until failure.

5. There is no definite elastic limit for tile; that is, the proportional limit usually coincident with failure.

6. An incipient failure is not always indicative that the ultimate failure is being approached, as it often occurs early in a test.

7. In general a tile develops greatest compressive strength when laid on end.

8. The tile having the highest modulus of elasticity may not have the greatest strength, but, in general, if the modulus is high, it is to be expected that the compressive strength will also be relatively high.

9. The dark and medium buff tiles have approximately the same relative compressive strengths and moduli of elasticity. The average compressive strength of tiles of these colors tested on end is about 7,500 lb. per square inch, with a possible range from 4,500 to 12,000 lb. per square inch, and the average modulus of elasticity is about 4,430,000 lb. per square inch, with a possible range from 2,800,000 to 6,200,000 lb. per square inch. The same properties of light-burned tiles are on an average about 30 per cent lower.

10. The maximum comprehensive strength of tiles varies approximately inversely with the percentage of absorption.

11. The percentages of absorption of tiles vary with the color. In general, the darker the tiles the lower the percentage of absorption is likely to be.

Price of Common Brick for Past 4 Years.—At the first annual convention of the Common Brick Manufacturers of America at Chicago, last February, information was collected from the delegates regarding the prices of common brick in various cities. The following table shows the trend of prices for the years 1916-1919 in 9 large cities:

	1916	1917	1918	1919
Boston	$[illegible]	$[illegible]	$17.00	$[illegible]
Chicago	7.00	9.00	12.00	12.00
Cincinnati	10.00	13.00	15.00	16.75
Detroit	9.00	11.00	12.00	13.60
Los Angeles	6.00	8.00	14.00	12.50
Louisville	8.50	12.50	20.00	17.50
*New York	7.35	[illegible]	10.85	[illegible]
Philadelphia	8.50	12.50	14.00	19.00
†San Francisco	7.50	10.00	11.00	12.50

*Delivered at ferry. †Delivered at plant.

New 260 Ft. Span Vertical Lift Bridge of Pennsylvania R. R.

A few weeks ago the Pennsylvania Lines west of Pittsburgh placed in operation a 260-ft. double track vertical lift bridge designed by Waddell & Sons, Inc. The bridge spans the Louisville & Portland Canal adjacent to the Ohio River at Louisville, Ky. As this structure is perhaps the latest development in lift bridge construction the following description, taken from an article by Dr. J. A. L. Waddell in the April Journal of the American Society of Mechanical Engineers, should be of interest.

The double-track span, which is 260 ft. long between centers of end bearings, weighs about 3,000,000 lb., and is lifted 32.4 ft. in 45 seconds. There are 64 counterweight ropes 2⅛ in. in dameter, passing over the four 15-ft. sheaves. The motive power consists of two 150-hp., 220-volt, a.c., 60-cycle, 580-r.p.m. motors equipped with solenoid brakes. Magnetic control is used. Speed reduction from the motors to the winding drums is made through a train of thre sets of spur gears to a cross-shaft having a pinion at each end meshing with two drum gears.

Vertical Lift Bridge Over Louisville and Portland Canal.

The operating drums which raise or lower the span are quite similar to those used on the Don River bridge in Russia. However, the detail of the cross shaft has been improved by adding two bearings and two couplings, thus giving more rigid supports for the pinions and making the lengths of shaft between the center main frame and the drum frames truly flexible. This detail eliminates entirely any trouble from errors in the alignment of the three frames, which otherwise would cause considerable friction and loss of power. Hand operation is provided for by two 4-arm capstans.

There are 16 plow steel operating ropes, each 1 in. in diameter, the drums and sheaves over which they run being 36 in. in diameter. These ropes work in pairs, i. e., there are two up-haul and two down-haul ropes at each corner of the span. The take-up devices for the ropes are eyebolts threaded over the entire length, with anchorage attachments at top and bottom of towers.

The counterweight sheaves are the heaviest yet built. They are constructed of steel plates, angles and castings. Each rim segment is fastened to the side plates by a sufficient number of rivets to take the entire load coming upon it from the ropes; and ½-in. spaces were left between the segments, so that there might be no trouble if the lengths of the segments should overrun. It was originally intended to fill these spaces with hemp; but the cutting tools gave trouble when the machining of the grooves was begun; and it was found necessary to fill them with babbitt. The trouble previously experienced from bad fit of side plates on the hub casting was eliminated by making the said side plates bear directly on the shaft instead of on the hub casting. The hole for the shaft was bored out after the sheave was completely assembled and riveted. The journals are 22½ in. in diameter and 24 in. long, the overall length of the shaft being 7 ft. 8 in. The hub is keyed to the shaft by three keys 1½ in. wide and 1 in. deep, secured from longitudinal movement my set screws. The bearings are lined with phosphor-bronze bushings for high pressure and low speed. Oil grooves are [illegible] lubricant being supplied from [illegible] grease cups.

The rail locks are of [illegible] type, standard with [illegible]. The [illegible] at each end of the span are driven by a [illegible] motor. Limit switches are [illegible] at each end of the travel. The controllers for the rail-lock motors are interlocked with the signal system, so that the locks cannot be opened until the signals are set against train movements over the bridge, and so that clear signals for train operation cannot be given until the locks are closed. The controllers are also interlocked with those for the main operating motors so that the current cannot be supplied to the latter until the locks have been opened, and so that the locks cannot be closed until [illegible].

The span is kept in correct position during motion by guide rollers, which roll on vertical guides on the outsides of the tower columns. There are eight rollers for trans- [illegible] one at each L_0 point and one at each U_0 point. [illegible] by two rollers at each L_0 point at the fixed end of the span. There is considerable play in the guides, so as to eliminate any possibility of binding. On account of this play they do not center the span closely enough for the rail locks, which have very little play. For this reason there is placed a transverse centering casting, having very little play, at the middle of each end floor beam. In earlier designs a transverse centering casting was placed at each L_0 point; but considerable play had to be left in these castings to provide for expansion and contraction, and they did not center the span accurately enough for the rail locks.

The train thrust is cared for by two thrust castings, one at each L_0 point at the fixed end of the span.

In order to eliminate jar when the span seats, there are provided air buffers near each end of each of the end floor beams. Adjustable needle valves on the exhaust ports of the buffers enable the resistance of the said buffers to be varied at will.

Bridge locks were not used, but the counterweights were made about 6 tons lighter than the span, the excess weight of the latter overcoming any tendency for it to rise.

The span can be handled from the machinery house, which is located at the center thereof, or from an interlocking tower on shore about 100 ft. from the south end of the span. It is intended to operate the span from the machinery house until the operators become thoroughly familiar with the manipulation, after which it will be operated from the interlocking tower. Duplicate switchboards, with indicator lamps, meters, etc., are placed in each house. The main switchboards and the resistances are located in the machinery house.

Each motor is equipped with a solenoid brake. In addition there are hand brake and a motor-operated brake. The lever of the hand brake is in the machinery house on the span, and gives the operator graduated braking power, so that he can stop the moving mass without jar. The controller of the motor-operated brake, which has three degrees of braking power, is located in the interlocking tower. These braking devices are not of great importance in a slow-moving bridge like this one; but for a high-speed bridge, which will coast for several feet after the current has been turned off, they are much more important.

The erection of the lift span was quite difficult, as traffic had to be maintained over the bridge and navigation could not be interfered with. The old moving span was a swing. It was at first proposed to erect the new span in its fully lifted position. As the counterweights would then have to be built at the lowest point of their travel, it would have been necessary to leave large notches in them for the passage of trains. This scheme was abandoned for that and other reasons, and a new one was worked out. Permission was secured from the United States Government to leave only a 100-ft. channel near the north tower. This channel was spanned by a plate-girder lift span of the same type as the main span, worked by hand-operated crabs. After the main-lift span towers were partly erected, navigation was stopped for a few hours while one end of the swing span was removed, the gallows frames for the plate-girder span towers were erected, and the plate-girder span placed in position. The remainder of the swing span was then removed, the towers erected, the sheaves and ropes placed thereon, and the counterweights constructed on falsework resting on the piers and floor beams. The south portion of the lift span was then erected, also the north hangers; and the counterweight ropes were attached. The machinery was erected complete and thoroughly tested out. Navigation was then closed for a day, the plate-girder span removed, the remainder of the lift span erected and riveted, and the operating ropes connected up.

Special care was taken in the aligning of the main-sheave bearings. This was done by means of a steel straight-edge as long as the shaft. The bushings had been scraped to fit the shafts in the shop, the shafts and bushings being match-marked. The aligning was so carefully done that when the sheaves were hoisted up they fitted perfectly in the bearings, and each 38-ton sheave could be rotated by one man. The machinery and motors were also aligned and tested out very carefully. The motors were run for several hours before the operating ropes were attached to the drums, in order to get the machinery into smooth-running condition and to determine if there were any poorly aligned bearings. Any hot bearings which developed were realigned. The machinery and the electrical equipment were in perfect operating condition before the operating ropes were attached to the drums and before the plate-girder swing span was removed.

Waddell & Son, Inc., has lately designed deflection bearings for main sheaves which insure a uniform pressure over the entire length of the journal. With the high bearing pressure used in the design of journals for lift-bridge sheaves and bascule trunnions this is extremely advisable. The use of this type of support greatly simplifies the problem of aligning the bearings.

One general fault of the electric equipment of movable bridges may be pointed out—that of using too small power lines. The overload capacity of the motors for vertical-lift bridges is called into play if a span becomes unbalanced, and, for bascules, when operating against a high wind; and this requires power lines of ample capacity. This point is not quite so serious in the case of direct-current motors, as the drop in voltage in the power line will merely cause the motors to run slower; but with alternating-current motors the drop in voltage reduces the torque materially, because the torque of such a motor varies as the square of the voltage. For instance, a 10 per cent drop in voltage means nearly a 20 per cent drop in torque. This point requires special attention when the power lines are long.

The Purposes of an Engineering Society

In his presidential address at the annual meeting of the Engineers' Society of Northwestern Pennsylvania, Mr. Armin Schotte, C. E., outlined as follows what he believes should be the aims of the society and its part in public affairs:

During the pioneer days, and up to near the close of the last century, engineers organized themselves into societies, which became national in scope. The purpose of these societies was to enlarge the sum total of technical knowledge by the interchange of information among themselves. Such work was of the utmost importance at that time, and was a material factor in adding to the store of available data.

During the last twenty years, however, conditions have changed, and in many cases successful steps have been taken to remedy them. What has proved antiquated and practically useless in the case of the national societies would be still more so in smaller local organizations such as ours. So, since we can hope, as a body, to add but little to the sum total of new engineering knowledge, and if we tried, would probably be wasting time which might be put to a better purpose, why undertake it?

The question naturally arises, What are the aims which justify us in maintaining and fostering our society? Without concerted effort in any way, but rather sporadically, new methods have been developed in the conduct of local engineering associations, and I am happy to say that we have, unconsciously perhaps, generally pursued a policy in harmony with them, to which I believe this society owes a large part of its successful growth.

The ultra-serious consideration of any technical subject has either very little or no place in this new policy. The programs are made up and the subjects treated in a manner to interest not merely specialists, but all classes of technically trained men; and in a large number of cases even laymen. The meetings thus assume an attractiveness which will assemble a maximum number of engineers of various lines, and also laymen, thus aiding to establish proper and pleasant relations among the engineers themselves, and to bring the profession before the public in an effective manner. By continuing this policy we shall soon be able to extend our work and help ourselves and every other engineer to conserve and maintain all of the rights and privileges, both mental and legal, to which the individual and the profession at large are justly entitled; to render to the public such service as we are qualified to perform; to create the proper appreciation of the function of the engineer generally, be he employee or maintaining an office of his own, and to compel a recognition for ourselves as a necessary factor in the civic and political growth of our community and the nation.

Business Methods for the Building Contractor*

By GEORGE A. RUTHERFORD, Cleveland, O.

It has been said by someone that the three elements of business are labor, capital and management. I think it might be said also that the management in the building business is divided into two phases, namely, the supervision and the office administration. It is true that in late years a great many men have come into the field who are college men, and technically trained, and men trained in the offices of contractors. I think it also remains true that the great majority of contractors are men who served their apprenticeships in one of the principal parts of the building business, and who have come up from the position of journeyman to a foreman, then a superintendent, and afterwards they have gone into business for themselves. Those men have not had an opportunity to study business methods.

I do not think that the contractor has advanced as a business man to the extent that men in other lines like merchants and manufacturers have. I think that is largely due to the fact that the contractor has not had the advantages, possibly, which they have had.

It has been the idea that the contracting business was a gamble, and was very risky. It is not any more risky than any other business. It is simply a matter of knowing it, and when a proper system is used by a contractor, he can rest assured that he will go along just as well as men in any other line of business.

One of the principal things is the estimate. I have here an enlarged copy of the estimate we use in our office. Of course, the estimate might have 50 or 60 sheets. On the first sheet is the summary of the entire estimate. Of course, the heading is just the same as any contractor would use, with the owner's name, the designer and the location, and the estimate number, and listed by and "checked by," "dates," etc. This sheet shows:

1. General requirements.
2. Job organization.
3. Temporary construction and sheds.
4. Plant and tools.
5. Concrete plant.
6. Clearing site.
7. Excavation.
8. Foundation work.
9. Waterproofing and dampproofing.
10. Concrete—plain.
11. Reinforced concrete.
12. Brick work and masonry.
13. Stone and marble.
14. Terra cotta.
15. Interior marble and tile.
16. Structural steel and iron.
17. Ornamental iron.
18. Carpentry.
19. Metal doors and windows.
20. Glass and glazing.
21. Plumbing and sewers.
22. Heating and ventilating.
23. Plastering.
24. Painting.
25. Roofing.
26. Sheet metal.
27. Electric work.
28. Sprinklers.
29. Elevators.
30. Building equipment.
31. Ground work.

Now, taking up these first six headings as an illustration: They are all subdivided into other headings, and the estimator, in checking off his quantities and reading the specifications, checks items in the specifications; so that there is nothing under the heading that can be overlooked.

For instance, under "No. 1 General Requirements," we have these items:

Building permit.
Bond.
Fire insurance.
Liability insurance.
Contractors' association.

The latter item, in Cleveland, is a percentage of the amount of the contract, the same as it is in some other cities, namely, ¼ or 1 per cent. It is part of the cost of the job, and can easily be put in there. Then we have:

Water.
Street permit.
Survey.
Contingencies.

No. 2 is "Job Organization and Expense," and under that heading comes:

Superintendent.
Timekeeper.
Engineer.
Watchman.
Telephone.
Cartage.
Cleaning up.

No. 3. "Temporary Construction and Sheds":

Our office.
Architect's office.
Cement shed.
Closet.
Fences and walks.
Roadways.

Under No. 4, "Plant and Tools," come:

Hoisting engines.
Hoisting tower.
Mortar mixer.
Scaffold plank.
Small tools.
Rope and tackle.
Water lines.

No. 5, Concrete Plant:

Mixer.
Hoisting engine.
Hoisting tower.
Chutes.
Charging plant.
Storage bins.
Carpenter shop.

No. 6, Clearing Site:

Removing old buildings.
Clearing site.
Shoring, adjacent buildings.

Now, that is enough to illustrate these general headings. We will now take up "brick work and masonry," and under that title are these several heads:

Common brick.
Face brick.
Pattern brick.
Ground brick.
Fire brick.
Enamel brick.
Hollow brick.
Stack brick.
Special shapes.
Partition tile.
Packing tile.
Interlocking tile.
Gypsum block.
Fireproofing beams and columns.
Rubble masonry.
Backing up.
Toothing old walls.
Connecting present building.
Wall ties.
Setting lintels.
Setting hangers.
Outside scaffolds.
Coping.
Curbing.
Pointing.
Cleaning down.
Steps.
Boiler settings.
Flue linings.
Paving.
Chimney caps.
Safety treads.
Base.
Sidewalk lights.
Cleanout doors.
Chutes—coal and ash.
Furring.
Floor construction.
Flat arch construction.

Of course, all the headings are divided the same way, so that an estimator can hardly overlook an item if it is mentioned in the specifications. He must have some sort of a cost keeping system in order to arrive at the units to use, but, take brick work, for instance; it is not difficult; you know the cost of brick, the cost of the sand, the cost of the cement and lumber, and you know about what the labor ought to be on certain kinds of work; and those unit prices are figured out on another sheet.

When you have the unit price, it is only a matter of mathematics to figure out the quantity and apply the rate; and that summary on each trade, of course, is carried out on the front.

Now, there are some jobs where you cannot anticipate all the things that may come up, where, for instance, it is difficult to work, or where the architect is very fussy and you do not know what he is going to want; so you must put in a "contingent" item for safety, just as the engineer puts in a factor of safety in computing his calculations on the building.

The first thing I made up my mind to do was that I was going to know what the cost of a job was, if I didn't know anything else; and I think the first job I did was putting up partitions under a big candy factory in Cleveland. I told the head bookkeeper at that time that I wanted to keep track of my work, and he gave me a form that they used in their business. Of course, he made some changes in it for me; but that is practically the same sheet that we have used ever since. That was in 1896, 22 years ago. I don't think this

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*From an address delivered Feb. 25 at the 8th annual convention of the National Association of Builders' Exchanges, Milwaukee.

[illegible] would be [illegible] keep the cost on for a [illegible] we have started to take [illegible] a job department and [illegible] cost sheet will be applicable [illegible] because you can use just as [illegible] We have the "heading" [illegible] description of the work," and if it is a contract, the contract price is put in; or, if it [illegible] a column for "extras." We make it a point to have a regular order for all costs and [illegible] put in there. So that [illegible] necessary to do is to [illegible] and amount of the extras.

On the other side are the "order numbers," and as orders are made out for work on this job, the order number is put in, and before the job is footed up, they see to it that the order numbers are all checked off as having been invoiced. [illegible] they come in. It is not necessary to itemize everything, but the invoice and the amount of it is put in there; so that you have the cost of the material, and here also is the time. There is room for some 20 or 22 men for 31 days; and of course you can use as many sheets as are required. If you have 100 men or 200 men you simply have that many more sheets, then we keep the different trades on different sheets, so as to put up the different trades separately for any purpose, the workmen's compensation particularly.

When our sheet is completed we have an itemized bill; if a contract, the contract price; and the extras; and before that is put away, the cost is put on and the selling price, and the gain and the percentage of gain. And then that is put away with all the records on the job, and we know just what we are doing on each job. If we do not show a gain, we have a little session and see what is the matter.

I want to say, too, that if the contractor gets into the habit of doing work that way, keeping track of things in that way, he will have a little more time to give his attention to the larger things than estimating. I do not believe the contractor ought to do estimating when his business gets to a point where he has something else to do, nor anything else. I find that after getting a system of this kind worked up, and getting an organization, I can go away to conventions and the job is going on just the same, and maybe better than if I were there.

City Art Commissions and Building Departments

That city art commissions should have greater power and should co-operate with building departments and pass on all plans for all buildings, private or public, is suggested by Mr. F. W. Fitzpatrick, Architect Construction Department, Bankers' Realty Investment Co., Omaha, in an article in the March Open Court. He goes on to say: Buildings on any one block should conform to certain major lines, they should not be allowed to scream at each other, there should be a certain harmony of color and material, an effort made toward the really artistic. As it is now buildings are planted down every one different from the other, a new and sometimes startling creation every 25 ft., for all the world as if a confectioner attempted a novel confection by sticking together slices of every imaginable kind, color, shape, and previous condition of cake he could lay hands upon and then wonder at the hodge-podge effect.

Why should we have to look upon buildings that appal us with their utter ugliness? Why should we put all our efforts into one class of building? For instance, in Washington there are wondrously fine public buildings, marvels of art, but the private individual is permitted to build any freak construction he wishes and the uglier it is the better it seems to serve his purpose. In consequence there are miles and miles of hideous brick rows and, in spite of the beautiful Government buildings, the city as a whole is irreparably marred, spoiled beyond redemption. Everywhere, in Cleveland as well as Washington, in San Francisco as well as in New York, there are misfits, awful efforts at originality, colors that swear at one, "designs" that were conceived in sin and brought forth in terrible travail.

Results of Flat Slab Floor Tests at Western Newspaper Union Building, Chicago

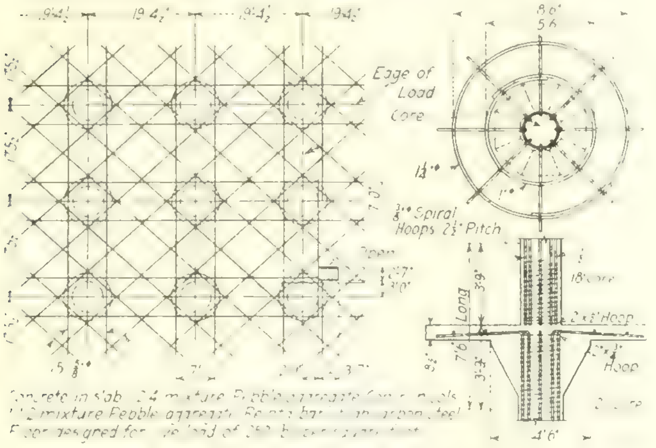
In the Nov. 28, 1917, issue of Engineering and Contracting we described briefly some tests that were being conducted at that time on the flat slab floors of the old Western Newspaper Union Building in Chicago, and gave some preliminary results. The complete discussion of these tests, together with data and conclusions, are given in a Bulletin written by Arthur N. Talbot and Harrison F. Gonnerman and issued lately by the Engineering Experiment Station of the University of Illinois. The tests brought out a great many interesting facts and should add to the confidence that engineers have in the present designing methods in reinforced concrete.

The Western Newspaper Union Building had to make way for the new Union Depot and the opportunity was utilized to apply a test load much greater in proportion to the design load than had been used in previous tests. A load of 913 lb. per square foot was applied to four panels of a floor that was originally designed for 250 lb. per square foot.

View of Western Newspaper Union Building at Time of Test.

Two types of floor construction were used in the building. The first five floors were slab and girder type; the 6th, 7th, and 8th floors were Turner mushroom flat slab type (four-way reinforcement). The floors of the building were divided into panels 17 ft. 5½ in. by 19 ft. 4½ in. The test was made on the sixth floor. This floor was designed for a live load of 250 lb. per sq. ft. and was nominally 8½ in. thick. A considerable variation in thickness was found, the measured thickness over the test area ranging from 7.5 to 9.8 in. In general, the thickness was greater away from the columns than in the vicinity of the columns. The interior columns were octagonal in form, 24 in. in short diameter below the floor tested and 21 in. in short diameter above it. The inside diameters of the hooping of the columns on the 5th and 6th floors are given on the plans as 21 in. and 18 in., respectively. The column capitals were pyramidal; the short diameter at the top of the capital was 54 in. The building plans called for 15⅝-in. round bars in each of the four bands of reinforcement in the floor slab and indicated that over most of the columns in the test area there were laps in certain bands. After the test was made, the floor was broken into and the location and extent of all laps and the position of reinforcing bars with respect to the surfaces of the slab were found. In several places the arrangement of reinforcement differs from that given in the building plans. In three places in rectangular bands the reinforcement for positive moment was double that given on the plans (30 bars instead of 15). The lapping of bars at columns was generally greater than that indicated on the plans. In most cases, the length of lap and its position were such that the extra metal was effective in regions of greatest moment. No reason is apparent for the lapping of bars between columns. There was no reinforcement for negative moment in the region midway between columns. The measurement of position of bars with respect to the surface of the slab showed considerable variation at the several columns. At the columns the distance of the centers of the bars of the top layer from the upper surface of the slab varied from 0.90 in. to 2.00 in., and that of the lower layer from 3.60 to 4.00 in. At points between columns the centers of the bars of the rectangular bands were from 2.30 in one case to 4.20 in. above the lower surface of the slab. In the region of the center of the panel the centers of the lower layer of diagonal bars were from 1.20 to 2.20 in. above the lower surface of the slab.

The variation in amount of reinforcement available at the different sections of the slab due to the diversity in amount and position of laps, and the variation in depth of reinforcing bar and thickness of slab, as well as variations in the quality and stiffness of the concrete in different parts of the loaded area, may be expected to cause some lack of uniformity in the stresses and deflections at points similarly located on the test area.



Plan of Test, Portion of Floor and Typical Column Detail.

The concrete in the slab was 1-2-4 mix; in the columns 1-1-2 mix was used. The coarse aggregate was gravel. Pieces of the concrete were cut out from the floor and sawed into test prisms approximately 5 in. square and 16 in. long; one face of the prism was coincident with the upper surface of the slab. The concrete was taken from parts of the slab which had not been highly stressed and which was relatively free from reinforcing bars and cracks. The results of the tests are given in Table I.

This table should be of interest in that it gives strengths in compression of concrete that has not been made in the laboratory, that is older than most laboratory specimens and concrete that has been in use.

The strength of these test prisms ranged from 3,190 lb. per sq. in. in panel B to 5,460 lb. per sq. in. in panel A, and the initial modulus of elasticity from 3,500,000 to 5,100,000 lb. per sq. in. When the floor was broken up after the test, a noticeable difference was found in the quality of the concrete in the four test panels. The concrete in panels A and D appeared much stronger and harder than that in panels B and C. That in panel D was very hard.

TABLE I.—COMPRESSION TESTS OF CONCRETE PRISMS

Specimen.	From panel.	Length, inches.	Section, inches.	Loaded area, sq. in.	Maximum applied load, lb.	Unit compressive strength, lb. per sq. in.	Modulus of elasticity, lb. per sq. in.
A1.....	A	16.0	4.6 by 4.8	22.1	71,000	3,210	4,500,000
A2.....	A	16.8	4.7 by 4.7	22.1	119,300	5,400	5,100,000
A3.....	A	16.2	4.9 by 3.9	19.1	104,400	5,460	4,800,000
					Average..	4,690	4,800,000
B1.....	B	18.0	6.5 by 4.5	29.3	93,400	3,190	4,200,000
B2.....	B	15.0	4.7 by 4.7	22.1	79,100	3,580	3,500,000
					Average..	3,385	3,850,000
D1.....	D	16.0	4.5 by 3.0	13.5	48,600	3,600	4,600,000
D2.....	D	16.5	5.1 by 2.5	12.8	42,800	3,340	4,500,000
D3...	D	10.0	4.9 by 3.1	15.2	60,600	3,990	....
D4...	D	9.5	5.0 by 3.1	15.5	59,700	3,850	....
D5...	D	8.0	4.5 by 3.2	14.4	48,200	3,350	....
					Average..	3,626	4,550,000

Steel coupons were cut from reinforcing bars at different places in the tested floor. The bars gave an average yield point by drop of beam of 63,600 lb. per sq. in. and an average ultimate strength of 101,300 lb. per sq. in.

The methods of tests were not unusual and are fully described in the article referred to as well as in the bulletin. It is to be regretted that funds were not available at the time to enable tests to be made of the other floors of the slab and girder type and other panels for corroboration of the test on the Turner type.

A careful comparison between magnitude of the resisting moments developed in sections of the slab and the bending moments due to external forces. Since only the tensile stresses on the bars can be actually computed the resisting moment based on their strength may not account fully for the bending moment. The tensile strength of concrete assists the tensile resistance, and is especialy influential in regions away from cracks.

The comparisons were made on the basis of the full analytical value of the bending moment and by considering one-third of it as positive moment and two-thirds as negative moment. The Joint Committee on Concrete and Reinforced Concrete recommended for the sum of the positive and negative moments a value which is about 85 per cent of the analytical value heretofore used and recommended that the distribution be three-eighths positive moment and five-eighths negative moment. The sum of the positive and negative moments accounted for by the measured stresses in the reinforcing bars has nearly the same value as the sum of the moments recommended by the Joint Committee. The negative moments so accounted for are 13 per cent higher than the value recommended by the Joint Committee, and the positive moments are about 73 per cent of the committee's values.

Four days were consumed in removing the load. Four hours after the last of the load was removed, readings were taken on the gage lines and deflection points, and twenty hours later another set was taken. The cracks in both upper and lower surfaces of the slab had closed so that they were not easily traced. The recovery in deflection at the centers of the panels was about 75 per cent; at other points it was generally greater. The recovery in strains in steel and concrete was also large. Even where high stresses and open cracks had been observed the residual strain in steel was not more than that to be expected from the lack of interlocking of particles at the cracks. In the region of high compressive stress in the concrete the recovery at the principal gage lines was 75 per cent or more; in the reinforcing bars the recovery averaged about 80 per cent. In general the action of the slab was that of concrete of high quality.

With reference to the design of the slab, it may be noted that the slab was strongly reinforced, though the reinforcing bars were not distributed to the best advantage and the laps were not placed so as to be effective.

Although the nominal thickness of the slab (8½ in.) was less than that required by building regulations, the slab fulfilled the common requirements for compressive and shearing stresses in concrete of the high quality shown in the tests of prisms taken from the slab. The provisions of the Joint Committee on Concrete and Reinforced Concrete for bending moments and working stresses in concrete of 3,000 lb. per sq. in. strength give a thickness about the same as the designed thickness of the slab.

As soon as the load was removed, portions of the floor in the four panels of the loaded area were broken into to recover the reinforcing bars at important sections. Measurements of the position and location of the reinforcing bars were made for use in calculation. The thickness of the floor was measured at a number of points to check the values obtained from level readings. Photographs were taken to give a record of the position and location of reinforcing bars and their laps. As the wrecking of the floor by the contractor progressed, further measurements of the position of the reinforcing bars and their laps, including those in the bands outside of the loaded area, were taken.

Among the many valuable conclusions are the following:

The tests of samples of the concrete from the slab, as well as the hardness and toughness of the concrete observed in breaking up the slab, indicate that the concrete was of unusually good quality and that it had high strength and [illegible] The [illegible] under load was that to be [illegible] concrete. The effect [illegible] concrete and on the de- [illegible] load was slight, even [illegible] the maximum load of 913 lb. [illegible] would not exist at an [illegible] removal of load, the recovery [illegible] n deflection at the centers of the panels was about 75 per ent of that under load, and at other points generally more; [illegible] concrete was as large [illegible]

Although the arrangement of bars was not as recommended, the amount of reinforcement for negative moment, considering all available bars over the area used, was as much as that required for the negative moments recommended by the Joint Committee on Concrete and Reinforced Concrete, even though the slab was thinner than recommended for ordinary concrete. The amount of reinforcement for positive moment was more than 50 per cent greater than that required for the positive moments recommended by the committee. Although the nominal thickness of the slab [illegible] building regulations, it fulfilled the provisions of the committee for bending moments [illegible] concrete of a test strength of 3,000 lb. per square inch.

The action of the floor slab under test should give added confidence in the suitability and relibabilty of the flat slab as a [illegible]

The units were conducted under the direction of Prof. A. N. Talbot of the University of Illinois by H. F. Gonnerman, [illegible]

The Architect and the Building Contract

[illegible] has been made in the design of work entrusted to architects, largely due to men trained under French influence, writes Mr. T. E. Billquist in the April Journal of the American Institute of Architects. Many of these men have, however, a low opinion of the structural side of their profession, preferring to leave this entirely to engineers and contractors. By this self-chosen limitation of the function of their profession, the relative importance of general contractors and building engineers has increased, almost delegating to them the actual construction of buildings, leaving to the architect only the design. The natural development has been the employment of designers by the big contracting concerns and entire elimination of the professional architect. The only method of checking this tendency is the general adoption by architects of separate contracts with the different building trades, a system so much feared by the general contractors that they have been known to organize and refuse to bid on any work in any architect's office where such vicious methods were practiced.

When the architects reclaim, as a part of their profession, the knowledge of construction, including the proper use of standard and patented forms, and ability to properly supervise its execution, they will be trusted by the public with the great amount of building construction now exclusively done by contractors and engineers, work that is mostly in great need of suitable design. Architects trained in construction will probably, like the engineers, prefer to execute their designs under separate contracts. By direct dealing with all these contractors, the architects will learn to make good drawings as a basis for contracts, the improvement in this respect in good offices being very marked. The room for improvement in specifications is far greater and more urgent.

One of the best reasons for the general adoption of separate contracts with all the building trades, as against a general contract for most of the work, is the reduced cost to the owner, caused by saving of the overhead charges of the general contractor, sometimes by the commission he receives on changes or, occasionally, on subcontracts. By contracts direct with the firms that actually execute the work an architect who knows his business can get very good work for his client, frequently better work than under the general contract, making it true under normal business conditions that separate contracts give the owner under all circumstances equally good work for the same cost, frequently better work for less cost than work executed under general contracts.

The Building Contract of the Future*

By SULLIVAN W. JONES.

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False Assumptions on the Lump-sum Contract System.—The contract system which was in almost universal use before the war had revolved about two wholly false assumptions: One, that a modern building can be described by drawings and specifications with sufficient completeness to provide for an accurate computation of costs, and, hence, for bids on its construction that are fairly competitive; and the other, that the contractors' business is that of selling finished work, and that he is essentially a merchant, who should, but by no means always does, possess a specialized knowledge of the suitable and economical use of the things he buys and sells.

The first of these false assumptions leads us direct to a consideration of the sufficiency of the architect's service, while the latter involves a study of the contractor's status under this form of contract. We have thus established at least one direct relationship between the two fundamental questions. While they have been stated separately, so interwoven are they that discussion of them singly is impossible.

Speculative Elements in Lump-sum Contracts.—Let us assume for the moment that we wish to hold to the lump-sum form of contract and competitive bidding. Obviously, then, we must find some way of giving to the contractor in advance the information essential as a basis for fair competition on price? Can it be done? Drawings and specifications may be improved through further standardization; inaccuracies of quantities may be largely removed by the adoption of the quantity system; and the cost of work may be placed upon a more accurate basis by the "open-price," which will also raise the price standard and assure a better margin of profit to the contractors. But are these partial remedies all that is necessary.

There are always several ways of doing a thing, one less costly than another, and there will always be differences of opinion between the contractor and architect as to which is the best, or whether the substitute proposed is permissible under the contract. There will always be disputes over questions of quality because quality, both in workmanship and materials, is well-nigh impossible to describe.

There is another important speculative element in every lump-sum contract, and it will exist even if drawings and specifications could be perfected. It is this element of risk which has now acquired such proportions that no sensible man is willing to assume it. When a contractor signs such a contract, he sells short for delivery over a stipulated period of time, the quantities of labor and material required. In some localities, in times more normal than these, or than those to which we look forward, the risk of loss to the contractor from a rising labor market has been minimized by wage agreements with organized labor. In other places that stability has not been secured. And the material market never has been and never can be brought under control. Estimating, even under the most favorable conditions, will always involve risk to the contractor, and as long as there are risks, competition will be based on risks instead of work to be done. The low bid, whether it be too low or not, will always be the product of the greatest error or the assumption of the greatest risk.

Which Is Wrong, Competition or the Stipulated Price?—Let us examine the case for the lump-sum contract. I have said it had a corrupting influence on everybody involved in it. Almost every ill and every evil in the building industry, I am satisfied, may be traced to the lump-sum contract. Under it the interests of the owner and contractor are diametrically oposed. The contractor's profit lies between the actual cost of the work and the amount of the contract. The greater the cost, the less the profit, and vice versa. The contractor's aim is, therefore, to deliver as little as possible, while the interest of the owner is in exacting the utmost of the contractor. The contract stands between them, setting up antagonisms where there should be co-operation, creating conflict of purpose where unity of interest is essential to success. Under the lump-sum contract the contractor has been a merchant, buying and selling finished buildings.

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*From an address before the Institute of Electrical Contractors.

The arguments against the general contractor being a merchant are possibly more conclusive than any that can be directed against the merchandising function for the subcontractor, especially the subcontractor who manufactures and installs a product, but they apply, nevertheless, with the force of conviction to both. The general contractor manufactures none of the materials which he handles. He has no plant or factory and has no legitimate use for either. He has no capital invested in anything of permanent value to him. The money which he uses in conducting his business is a temporary substitute for the owner's capital ultimately represented by the finished building. What is it the contractor has to sell? Service, his expert knowledge of the fabrication of buildings. In the last analysis, service is the thing he has always sold, but instead of selling it to his employer, he has sold it to himself. The system has placed a premium on disloyalty and shrewdness in the contractor, rather than on engineering skill and efficiency.

The same contradictions have confused and misled the subcontractor. He has wasted his best energy fighting for trade discounts on the materials he purchases in order to resell them competitively at a possible profit. He, too, has struggled to make a livelihood through the purchase and sale of labor and materials when he should have centered his effort on perfecting his service and finding a market for it. If service is the commodity in which the contractor deals, and we wish to preserve competition, obviously, then, competition must be in service and not in the price for finished work. The value of service is measured in terms of results. If economy is one of the results looked for, and secured, let it be an asset to the contractor instead of stolen fruit to be concealed.

The Architect and the Lump-sum Contract.—But we have not yet put in all the evidence against the lump-sum contract. The architect has not escaped its insidiously evil influence. The average owner, the owner who is inexperienced in matters of construction, undertakes his venture on the assumption that the architect is omniscient, and that when a bid is received on the drawings and specifications it is all-inclusive. This is the fallacy of the complete and sufficient drawings and specifications. A mistake is made when an architect accepts employment without disclosing to his client the unavoidable limitations which are placed upon his service. As the work proceeds, omissions are discovered, differences arise as to what is meant by vague expressions and indications, and the architect is at once placed on the defensive with respect to the sufficiency of his drawings and specifications. He has the choice of confessing his plight to the client or covering it up by compromise with the contractor. Some pursue the former and honorable course; others, the latter. The position of the architect under such a contract is unwholesome. It is unfair to him. It is unfair to the owner who has sought the architect's advice on the basis of confidence. It is unfair to the contractor. It is a high tribute to the profession, and the professional tradition, that so few architects have succumbed to the temptations which constantly urge them to abandon the difficult role of conscientious servant.

That the architect is keenly alive to his untenable position, and to the gravity of the consequences to the whole building industry if conditions remain unchanged, is evidenced through the appointment by the American Institute of Architects of a Post-War Committee on Architectural Practice, charged with the study of the architect, his function, relation to the public and public interest, and his education; and by the principles adopted as fundamental by the Committee on Contracts and Specifications in connection with its deliberations on the cost-plus-fee form of contract. These two committees, beginning work on two distinct questions, have found that their labors are complementary; and I venture to predict that in the end their work will be co-ordinated, at least to this extent: That the Committee on Contracts and Specifications will perfect the cost-plus-fee form of contract and the other committee will recommend its universal adoption.

The Cost-plus-fee Contracts.—The cost-plus-fee contract, as we have known it, has been a compromise document. The status of the contractor, by reason of his contract liabilities, and by reason of the unchanged attitude of the architect and owner, was not radically different under this form of contract from what it had been under the lump-sum contract. While his interests coincide with those of the owner, the contractor failed to realize the nature of the relationship, and, consequently, his attitude of mind remained unaltered. The Committee on Contracts and Specifications feels that the change must be complete, and that such changes must be made in the document as will give the contractor a new picture of his status and responsibilities. The committee asserts that, "in the light of recent experiences of the Government in the use of the cost-plus-fee system, the following general principles are felt to be fundamental":

"(1) The contractor becomes in effect a professional adviser of the Owner, as his 'Construction manager' and should be relieved of all contract liabilities inconsistent with such a relationship; (2) For this purpose the Owner should pay directly for all materials and should enter directly into contract with subcontractors rather than having subcontractors make their contracts with the Contractor. Payrolls must perforce be paid by the Contractor and reimbursement made by the Owner; (3) In view of this professional relationship, no 'bond' guaranteeing performance is needed or proper, any more than for the architect."

It is difficult to comprehend at once the full significance of this statement. The principles enunciated find expression throughout the document. There was a discussion on the expediency of changing the term "contractor" to "constructor," or "manager of construction," or "constructing engineer," but it was decided that a wiser course to pursue was to use the old and familiar term and let the contractors' wishes gradually crystallize into the choice of some substitute term which would be more appropriate and more descriptive of the new function.

This is the wording of the clause, which, in the older form of contract, was captioned "subcontracts." It now bears the title "separate contracts":

"All portions of the work that the contractors' organization has not been accustomed to perform, or that the owner may direct, shall be executed under separate contract. In such cases, either the contractor shall ask for bids from the contractors approved by the architect and shall deliver such bids to him, or the architect shall procure such bids himself, and in either case the architect shall determine with the advice of the contractor and subject to the approval of the owner, the award and amount of the accepted bid. The owner shall contract direct with such approved bidders, etc., etc."

This clause, it will be observed, establishes the relationship between the so-called subcontractor and the owner or architect, which the subcontractor has sought to realize through the elimination of the general contractor.

Advantages of Cost-plus-fee Contracts.—It must be now plain that the architect's status and function cannot be considered without considering, also, the status and function of the contractor. It seems almost superfluous to point out the advantages to the whole building industry from making the cost-plus-fee contract the rule instead of the exception. It is important, however, for us to think of this proposed change in terms of results, so that we may all have a clear conception of what it is we are striving for. But when we think in terms of results, we again find it impossible to think of the architect and the contractor separately. First, the contractor, or let us call him the constructor, will be selected on the basis of confidence and his service record. Since the contractor's profit will no longer depend upon his ability to cheapen the work, which has been the motive underlying the general practice of offering substitutions, we may expect fewer discussions of this kind in the future. Considerations of price alone will less and less influence the selection of materials. The architect and the contractor will work together instead of in opposition. The knowledge and experience in construction which the architect lacks will be furnished by the "constructor." This, to my mind, is one of the most important results that will be secured, for it must be realized, and is realized by the thinking element in the architectural profession, that ability in design, which reaches its highest development only in men who are sensitive, imaginative, and impulsive, is wholly incompatible with the scientific quality of mind that works in exact terms of fact and statistics; an essential prerequisite to the proper performance of the "constructors" function. Under the cost-plus-fee form of contract, the architect, the contractor, and the owner enter into a tri-party agreement to accomplish a single end. It does not require much imagination to see in this change in the contractor's status the reincarnation of the master builder of the Renaissance, through a virtual, if not an actual part-

[illegible] produced the world's most [illegible] architectural monuments.

[illegible] the contractor and the in[illegible] of talents. If it cannot be [illegible] contractors will try to become architects as well, and that architects will attempt to become [illegible] few will succeed. Buildings will be either poorly constructed or poorly designed, and the loss to the public and in the prestige of the industry will be [illegible].

In connection with the adoption of the cost-plus-fee contract system, I wish also to point out the importance of a standard cost accounting system and the greater value of the [illegible] in education and in establishing mutual confidence.

There is one, and only one, serious difficulty which lies in the way of securing these fundamental reforms. It will be necessary to effect a change in the policy of the lender of money for construction. Relatively little new construction is carried forward without building loans. Such loans are usually a certain percentage of the contract cost of the building. The question is, can the great lending companies be made to feel that they will be amply protected in lending the same percentage on a carefully prepared estimate by a reputable "constructor," even though the amount of that estimate is not guaranteed by a contract and bond? I believe that, ultimately, such loans will be secured on the basis of confidence, even more readily and with less question as to values and risks than has been the case in the past. And I believe, also, that loans so made will be more secure than those made on the lump-sum contract ever have been. This must be so, because the building will be a better investment; both upkeep and depreciation will be less, and costs will rest on the stable foundation of true values, not on the insecure basis of [illegible].

Advantages of Bulk Cement

In a paper presented at the last annual convention of the Railway Storekeepers' Association, Mr. E. V. Aldridge, manager Sack Bureau Universal Portland Cement Co., summarized as follows the reasons why cement in bulk will net a saving as compared with its use in packages:

1. Net price of cement in bulk is less than in either cloth sacks or paper bags.
2. Sack losses are eliminated.
3. Less labor is required to handle cement from car to mixer.
4. No labor is required to count and bundle the empty sacks for return to manufacturer.
5. No bookkeeping on sacks is necessary.
6. No storage space need be provided for sacks.
7. No fire insurance on sacks need be carried.
8. No hauling expense and freight charges in connection with return of empty sacks.
9. No loss on account of cement being left in sacks because of carelessness in emptying.
10. No money is tied up in sacks. Such money draws no interest and is not refunded until the empty sacks have been received, counted and inspected by the manufacturer.
11. No money is spent for paper bags, which account of being capable of but one trip are a dead loss when empty.

The usual objections made to the use of bulk cement are:

1. Possible damage by water to the cement in transit or in storage.
2. Dust.
3. Difficulty in unloading, measuring and handling.

Cars used for bulk shipments are carefully coopered before loading to insure against possible leakage or damage in transit. If water does penetrate a leaky roof the damage is localized in case of bulk shipments, while if cement is packed in cloth sacks or paper bags damage will extend over large area. Storage in packages will not prevent absorption of water from the atmosphere. A tight weatherproof storage is required for either bulk or sacked cement. Especially at the mixer, bulk cement can be handled with less dust than sacked cement. Even though bulk cement is unloaded with no equipment other than shovels and wheelbarrows, users have effected a saving in handling cost. Furthermore, the men prefer to handle it in bulk. Cement in bulk can be measured just as accurately as sand or pebbles, all of which materials in concrete making are measured by volume.

Living Architecture*

A weakness of modern architecture is in its not having sufficient grasp of modern scientific construction. The failure of English engineering is that it is usually mean and brutal, like Charing Cross Bridge, or, ashamed of itself, it seeks for disguises like those of the intolerable Tower Bridge. Judging by its works rather than its claims to "science," our engineering seems often both ignorant and impotent.

The ideal for masonry has been definition and delicacy, sharply cut angles, moulding, carving. The ideal for concrete construction is much the reverse: it is that of continuous aggregation into a homogeneous, chambered mass; the structure is "cast"; simple forms and rounded edges are required. Its special disadvantage is in being liable to cracking, and the least cracking in such structures seems to destroy the possibility of our having any pleasure in them. A building of such a fabric should be as continuous and sound as a china vase. It is necessary first of all to improve the material so that it won't crack. Our continued use of materials like mosaic and cement floors in such a way that rivers or cracks wander over them after a few years is somewhat astonishing.

Once having mastered the material and having produced a fairly even surface, we have to bring out what it can best do on its own merits, and put away any attempt at imitating forms developed in stone and brick building. Curved lines in plan and slanting and curved surfaces would seem to be specially appropriate to this mud-like material which must be modelled as it were into form. Inferior angles of Roman rooms were usually rounded. Corners might be rounded both within and outside; cornices, if any, might be simple coves or rounds. The surface could be finished with white and color washes, plastering, painting, rough-cast, sgraffito, marble-veneer, mosaic, glazed tiling and glazed terra cotta applied in panels and medallions. The aim should be to develop structures in which the walls and roofs are all of a piece; and there is surely something exciting in such a mode of building. The general design must in every case be arrived at as the best constructive solution of the given problem, but it must be a fine and civilized solution, not a raw and haphazard one like so many of our engineering works. Exquisite common sense is wanted. The aim should be for masterly construction appropriately or even delightfully finished. Beauty in structures is not a question of mere shapes, but it is the evidence of mind acting on materials.

If we could have a fine market or railway shed (or even a cathedral) schemed like some of the wonderful war sheds drawn by Mr. Muirhead Bone, well built of its kind, flooded with light, carefully finished, brilliantly whitewashed like a lighthouse, and decorated with fine paintings, we might "catch our breath" once more at the sudden sight of a piece of living architecture.

One of the buildings which has most interested me recently is the newest museum building at South Kensington, temporarily completed with the "style" left out. Many of the temporary war buildings are also direct and structurally interesting. Although such buildings are frequently only skeletons, they demonstrate that a piece of architecture may be got to stand up without shamming dead.

Let us consider the "carcass" of an important public structure. A rim or lining of marble might be put around the doorway, and over it could be some fine heraldry carved, gilt, and colored from the design of one of our heraldic experts; not the fat, tame stuff we are accustomed to, but keen and vigorous. This would probably be enough, we don't want our buildings worried all over, we want richness and color and food for thought, but we also need bareness and relief and peace. Or a set of fine sculptured panels, about something, might be set low down where they could really be seen and loved—really loved—not tolerated or hated. Or an inscription really saying something in clear, strong lettering might be cut in in a band high up, or in a large panel, or, again, this might be in mosaic of gold letters on blue, or black letters on gold—not timid and frightened and non-committal, but an inscription to lift up our hearts. Or between the windows might be a set of really handsome medallions in glazed earthenware, either in relief or only painted devices, or portraits, but again, with some meaning and intention—surely we are rich enough to have meanings and intentions.

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*From an article by Professor Lethaby in the British journal the Builder.

The Design of Concrete Mixtures

During the past 3 years a large number of investigations have been under way at the Structural Material Research Laboratory, Lewis Institute, Chicago, which throw considerable new light on the subject of proportioning concrete. These investigations, carried out through the co-operation of the Institute and the Portland Cement Association, are being made under the direction of Duff A. Abrams, Professor in charge of the laboratory. The studies have covered an investigation of the inter-relation of the following factors: (1) The consistency (quantity of mixing water): (2) The size and grading of aggregates, and (3) The mix (proportion of cement). During this period about 50,000 tests having a bearing on this subject have been carried out. These tests have been confined largely to compression tests of concrete and mortars. The investigations have given a new insight into the factors which underlie the correct proportioning of concrete mixtures and show the limitations of older methods.

The results of the investigations are given in a bulletin prepared by Prof. Abrams and published a few days ago by the Structural Materials Research Laboratory. Inasmuch as the bulletin contains many new conceptions regarding the effect of certain changes in the proportions of concrete materials and brings out for the first time an improved method of proportioning concrete mixtures, it is reprinted below in greater part.

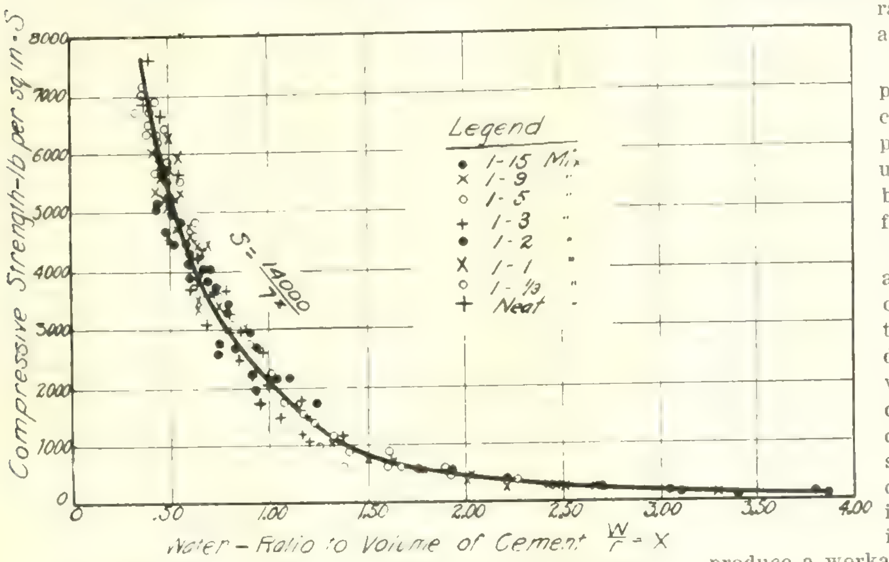


Fig. 1.—Relation Between Strength of Concrete and Water Content. Twenty-eight-day compression tests of 6 by 12-in. cylinders.

Among the most important principles which have been established with reference to the design of concrete mixtures are following:

1.—With given concrete materials and conditions of test the quantity of mixing water used determines the strength of the concrete, so long as the mix is of a workable plasticity.

2.—The sieve analysis furnishes the only correct basis for proportioning aggregates in concrete mixtures.

3.—A simple method of measuring the effective size and grading of an aggregate has been developed. This gives rise to a function known as the "fineness modulus" of the aggregate.

4.—The fineness modulus of the aggregate furnishes a rational method for combining materials of different size for concrete mixtures.

5.—The sieve analysis curve of the aggregate may be widely different in form without exerting any influence on the concrete strength.

6.—Aggregate of equivalent concrete making qualities may be produced by an infinite number of different gradings of a given material.

7.—Aggregates of equivalent concrete-making qualities may be produced from materials of widely different size and grading.

8.—In general, fine and coarse aggregates if widely different size or grading can be combined in such a manner as to produce similar results in concrete.

9.—The aggregate grading which produces the strongest concrete is not that giving the maximum density (lowest voids). A grading coarser than that giving maximum density is necessary for highest concrete strength.

10.—The richer the mix, the coarser the grading should be for an aggregate of given maximum size; hence, the greater the discrepancy between maximum density and best grading.

11.—A complete analysis has been made of the water-requirements of concrete mixes. The quantity of water required is governed by the following factors:

(a) The condition of "workability" of concrete which must be used—the relative plasticity or consistency;

(b) The normal consistency of the cement

(c) The size and grading of the aggregate—measured by the fineness modulus;

(d) The relative volumes of cement and aggregate—the mix;

(e) The absorption of the aggregate;

(f) The contained water in aggregate

12.—There is an intimate relation between the grading of the aggregate and the quantity of water required to produce a workable concrete.

13.—The water content of a concrete mix is best considered in terms of the volume of the cement—the water-ratio.

14.—The shape of the particle and the quality of the aggregate have less influence on the concrete strength than has been reported by other experimenters.

Effect of Quantity of Mixing Water on the Strength of Concrete.—Figure 1 shows the relation between the compressive strength and the water content for 28-day tests of 6 by 12-in. concrete cylinders. Mixes from 1:15 to neat cement were used; each mix was made up of aggregates ranging in size from 14-mesh sand up to 1½-in. gravel, a wide range in consistencies was used for all mixes and gradings.

The water content of the concrete is expressed as a ratio to the volume of cement, considering that the cement weighs 94 lb. per cubic foot. Distinguishing marks are used for each mix, but no distinction is made between aggregates of different size or different size or different consistencies.

When the compressive strength is platted against the water ratio in this way, a smooth curve is obtained, due to the overlapping of the points for different mixes. Values from dry concretes have been omitted. If these were used we should obtain a series of curves dropping downward and to the left from the curve shown. It is seen at once that the size and grading of the aggregate and the quantity of cement are no longer of any importance except in so far as these factors influence the quantity of water required to produce a workable mix. This gives us an entirely new conception of the function of the constituent materials entering into a concrete mix and is the most basic principle which has been brought out in our studies of concrete.

The equation of the curve is of the form,

$$S = \frac{A}{B^x} \qquad \text{(1)}$$

where S is the compressive strength of concrete and x is the ratio of the volume of water to the volume of cement in the batch. A and B are constants whose values depend on the quality of the cement used, the age of the concrete, curing conditions, etc.

This equation expresses the law of strength of concrete so far as the proportions of materials are concerned. It is seen that for given concrete materials the strength depends on only one factor—the ratio of water to cement. Equations which have been proposed in the past for this purpose contain terms which take into account such factors as quantity of cement, proportions of fine and coarse aggregate, voids in aggregate, etc., but they have uniformly omitted the only term which is of any importance; that it, the water.

For the conditions of these tests, equation (1) becomes,

$$S = \frac{14{,}000}{7^x} \qquad \text{(2)}$$

The relation given above holds so long as the concrete is not too dry for maximum strength and the aggregate not too coarse for a given quantity of cement; in other words, so long as we have a workable mix.

Other tests made in this laboratory have shown that the character of the aggregate makes little difference so long as it is clean and not structurally deficient. The absorption of the aggregate must be taken into account if comparison is being made of different aggregates.

The strength of the concrete responds to changes in water, [illegible] of the reason for these changes. The water ratio may be changed due to any of the following causes:

[illegible]

In certain instances a 1:5 mix is as strong as a 1:2 mix, depending only on water content. It should not be concluded that these tests indicate that lean mixes can be substituted for richer ones without limit. We are always limited by the necessity of using sufficient water to secure a workable mix, as is the case of the grading of aggregates. The workability of the mix will in all cases dictate the minimum quantity of water that can be used. The importance of the workability factor in concrete is therefore brought out in its true relation.

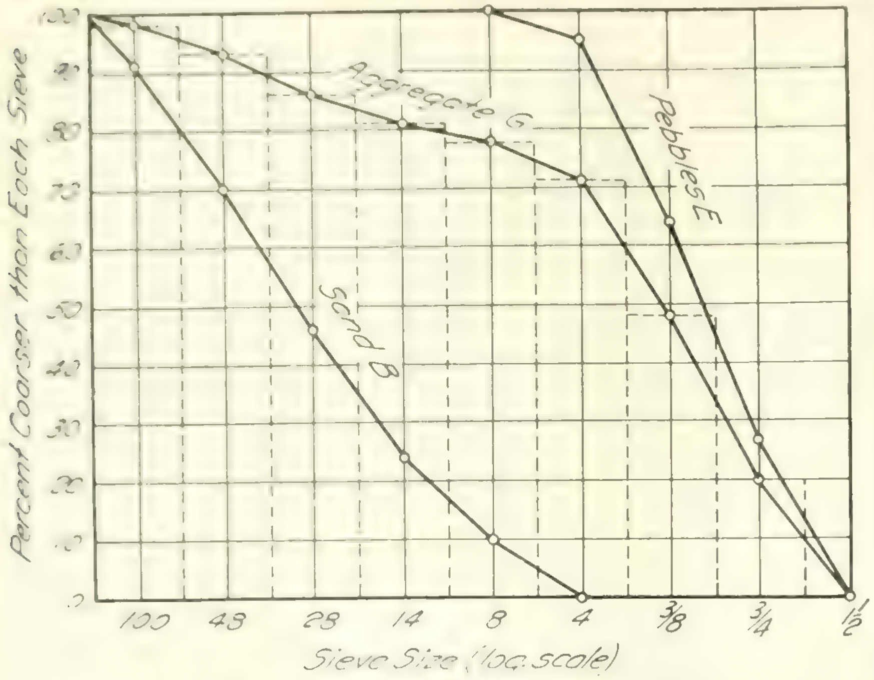


Fig. 2.—Method of Plotting Sieve Analysis of Aggregates. Sieve analysis curves for aggregates B, E and G in Table I

The problem of designing concrete mixes resolves itself into this:

To produce a workable concrete which has a given water-ratio using a minimum quantity of cement; or the converse, to produce a workable concrete with a minimum water-ratio using a given quantity of cement. The methods for securing the best grading of aggregate and the use of the driest concrete which is workable are thus seen to be only devices which enable us to accomplish the above-mentioned results.

Fineness Modulus of Aggregate.—The experimental work carried out in the laboratory has given rise to what we term the fineness modulus of the aggregate. This function furnishes a method of measuring the size and grading of the aggregate. It may be defined as follows:

The sum of the percentages in the sieve analysis of the aggregate divided by 100.

The sieve analysis is determined by using the following sieves from the Tyler standard series: 100, 48, 28, 14, 8, 4, ⅜-in., ¾-in. and 1½-in. These sieves are made of square-mesh wire cloth. Each sieve has a clear opening just double the width of the preceding one. The exact dimensions of the sieves and the method of determining the fineness modulus will be found in Table I. It will be noted that the sieve analysis is expressed in terms of the percentages of material by volume of weight coarser than each sieve.

A well-graded torpedo sand up to No. 4 sieve will give a fineness modulus of about 3.00; a coarse aggregate graded 4-1½ in. will give a fineness modulus of about 7.00; a mixture of the above materials in proper proportions for a 1:4 mix will have a fineness modulus of about 5.80. A fine sand such as drift-sand may have a fineness modulus as low as 1.50.

Sieve Analysis of Aggregates.—There is an intimate relation between the sieve analysis curve for the aggregate and the fineness modulus; in fact, the fineness modulus enables us for the first time to properly interpret the sieve analysis of an aggregate. If the sieve analysis of an aggregate is platted in the manner indicated in Fig. 2; that is, using the per cent coarser than a given sieve as ordinate, and the sieve size (platted to logarithmic scale) as abscissa, the fineness modulus of the aggregate is measured by the area below the sieve analysis curve. The dotted rectangles for aggregate "G" show how this result is secured. Each elemental rectangle is the fineness modulus of the material of that particular size. The fineness modulus of the graded aggregate is then the summation of these elemental areas. Any other sieve analysis curve which will give the same total area corresponds to the same fineness modulus and will require the same quantity of water to produce a mix of the same plasticity and gives concrete of the same strength, so long as it is not too coarse for the quantity of cement used.

The fineness modulus may be considered as an abstract number; it is in fact a summation of volumes of material. There are several different methods of computing it, all of which will give the same result. The method given in Table I is probably the simplest and most direct.

Some of the mathematical relations involved are of interest. The following expression shows the relation between the fineness modulus and the size of the particle:

$$m = 7.94 + 3.32 \log d \ldots\ldots\ldots\ldots\ldots (3)$$

Where m = fineness modulus
d = diameter of particle in inches.

This relation is perfectly general so long as we use the standard set of sieves mentioned above. The constants are fixed by the particular sizes of sieves used and the units of measure. Logarithms are to the base 10.

This relation applies to a single-size material or to a given particle. The fineness modulus is then a logarithmic function of the diameter of the particle. This formula need not be used with a graded material, since the value can be secured more easily and directly by the method used in Table I. It is applicable to graded materials provided the relative quantities of each size are considered, and the diameter of each group is used. By applying the formula to a graded material we would be calculating the values of the separate elemental rectangles shown in Fig. 2.

Fineness Modulus Strength Relation for Concrete.—Many different series of tests have shown that for a given plastic condition of concrete and the same mix there is an intimate relation between the fineness modulus of the aggregate and

TABLE I—METHOD OF CALCULATING FINENESS MODULUS OF AGGREGATES.

The sieves used are commonly known as the Tyler standard sieves. Each sieve has a clear opening just double that of the preceding one.

The sieve analysis may be expressed in terms of volume or weight.

The fineness modulus of an aggregate is the sum of the percentages given by the sieve analysis divided by 100.

Sieve	Size of Square opening		Sieve analysis of aggregates Per cent of sample coarser than a given sieve						
			Sand			Pebbles			
Size	in.	mm.	Fine (A)	Medium (B)	Coarse (C)	Fine (D)	Medium (E)	Coarse (F)	Concrete aggregate (G)*
100-mesh	.0058	.147	[illegible]	91	97	100	100	100	98
48-mesh	.0116	.295	[illegible]	70	81	100	100	100	92
28-mesh	.0232	.59	20	46	[illegible]	100	100	100	86
14-mesh	.046	1.17	0	[illegible]	44	100	100	100	81
8-mesh	.093	2.36	0	10	25	100	100	100	78
4-mesh	[illegible]	4.70	0		0	86	95	100	71
⅜-in.	.37	9.4	0		0	51	66	86	49
[illegible]	.75	18.8	0	0	0	9	25	50	19
[illegible]	1.5	38.1	0	0	0	0	0	0	0
Fineness modulus			1.54	2.41	3.10	6.46	6.86	7.36	5.74

*Concrete aggregate "G" is made up of 25 per cent of sand "B" mixed with 75 per cent of pebbles "E." Equivalent gradings would [illegible] per cent sand "B" with 67 per cent coarse pebbles "F"; 28 per cent "A" with 72 per cent "F," etc. The proportion coarser than a given sieve is made up by the addition of these percentages of the corresponding size of the constituent materials.

the strength and other properties of the concrete. We have seen that the reason for this result is found in the fact that the fineness modulus simply reflects the changes in water-ratio necessary to produce a given plastic condition.

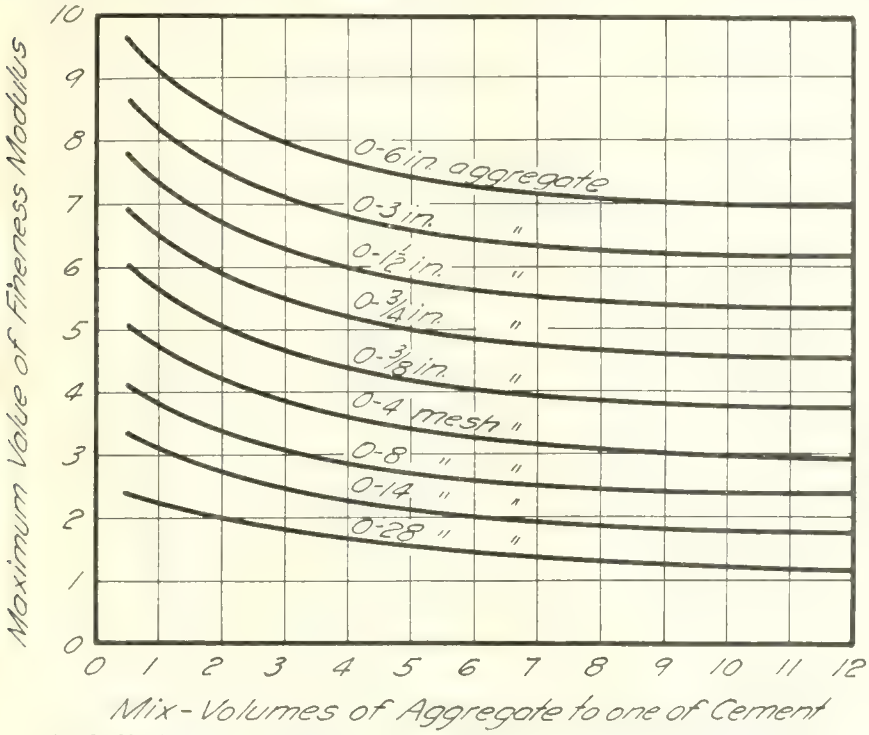


Fig. 3—Maximum Permissible Values of Fineness Modulus of Aggregate.

Graphical reproduction of Table III. These curves are based on the requirements of sand and pebble aggregate. For crushed stone aggregate the values must be reduced as noted in the table.

TABLE II—EFFECT OF GRADING OF AGGREGATES ON THE STRENGTH OF CONCRETE.

Compression tests of 6 by 12-in. concrete cylinders.

Mix 1:5 by volume; age at test, 28 days; stored in damp sand; tested damp.

Aggregates—sand and pebbles from Elgin, Ill. Aggregates were screened to different sizes and recombined to conform to predetermined sieve analyses.

The aggregates were made up in such a manner as to give the widest variations in the grading of the particles. All gradings had one common property, in that the fineness modulus was exactly the same—m = 6.04. The fineness modulus of the aggregate is the sum of the percentages in the sieve analysis, divided by 100.

The same quantity of water was used in all specimens of a given consistency. The 110 per cent consistency contains 10 per cent more water than the 100 per cent.

Each specimen was made from a separate batch.

Each value in the strength tests is the average from 5 tests made on different days.

Ref.	Sieve analysis of aggregate Per cent coarser than each sieve											Fineness modulus of aggregate	Surface area of aggregate sq. in.		Compressive strength of concrete at 28 days (lb. per sq. in.)	
No	100	48	28	14	8	4	⅜	¾	1¼	1½	2		Per lb. of aggregate	Per g. of cement	100% consistency	110% consistency
40	99	98	95	90	81	68	49	24	0			6.04	602	8.8	3,300	2,890
259	99	98	96	92	84	67	46	22	0			6.04	569	8.2	2,950	2,650
260	98	97	93	88	80	67	52	29	0			6.04	764	11.4	3,120	2,760
261	97	94	91	85	77	67	58	35	0			6.04	999	15.2	3,140	2,790
262	95	92	87	82	75	67	67	39	0			6.04	1,292	20.1	3,100	2,800
263	95	90	84	78	73	67	62	55	0			6.64	1,451	23.0	2,830	2 740
264	95	89	82	75	67	67	67	62	0			6.04	1,565	25.2	2,680	2,580
265	100	97	91	79	72	67	58	40	0			6.04	761	11.9	3,070	2,690
266	100	97	93	88	83	67	50	27	7	0		6.04	616	9.0	3,080	2,790
267	99	97	94	86	77	67	47	27	16		0	6.04	709	10.5	3,150	2,710
268	98	95	90	83	83	83	50	22	0			6.04	834	12.6	3,080	2,500
269	98	94	90	86	83	80	55	18	0			6.04	898	13.3	3,050	2,550
270	96	90	80	80	80	80	60	39	0			6.04	1,391	21.5	2,970	2,550
271	100	96	92	87	81	77	50	23	0			6.04	672	10.0	2,930	2,710
272	95	91	87	82	77	73	59	40	0			6.04	1,315	20.2	3,000	2,580
273	99	95	88	80	76	73	61	32	0			6.04	911	13.9	2,950	2,740
274	90	85	81	77	77	73	63	56	0			6.04	1,992	31.3	2,680	2,440
275	100	93	82	73	73	73	62	47	0			6.04	1,076	16.7	2,820	2,620
276	100	100	100	92	81	60	45	26	0			6.04	390	5.6	3,040	2,780
277	100	98	95	90	80	60	50	31	0			6.04	557	8.3	2,900	2,770
278	100	99	96	92	84	55	50	28	0			6.04	483	7.0	2,940	2,750
279	100	99	96	91	80	50	50	38	0			6.04	514	7.6	3,080	2,750
280	98	84	84	84	84	57	57	57	0			6.04	1,276	19.7	3,000	2,780
281	99	98	91	86	80	76	38	38	0			6.04	701	10.4	2,940	2,700
282	99	98	91	86	80	76	46	20	0			6.04	697	10.2	3,020	2,660
283	99	98	91	86	80	76	61	15	0			6.04	689	10.1	2,930	2,670
284	99	98	91	85	80	76	67	8	0			6.04	685	9.9	2,970	2,630
Average												6.04	904	13.8	2,990	2,690
Minimum value												....	390	5.6	2,680	2,440
Maximum value												....	1,992	31.3	3,300	2,890
Mean variation from average—per cent												....	34.4	37.2	3.41	3.01

Compression tests bring out the relation beween the strength of the concrete and the fineness modulus of the aggregate very clearly for each mix. There is a steady increase in the compressive strength of the concrete as the fineness of the aggregate increases, until a certain value is reached which corresponds to a maximum point. This maximum point corresponds to higher and higher values of fineness modulus as the quantity of cement in the mix is increased.

For all practical purposes and for ordinary ranges in concrete mix the fineness modulus strength relation may be assumed as a linear one. The comparison of the true and approximate relation is brought out in the discussion of the "Water Formula" below.

A given value for the fineness modulus of an aggregate can be secured with any combination of percentages in the sieve analysis which gives the same total, consequently, an infinite variety of gradings may be found which give aggregate of the same concrete strength. Table II gives the results of groups of tests which bring out the wide variation which may be made in the grading of aggregate without producing any essential variation in the concrete strength. Twenty-seven different gradings of the same aggregate were made up. These gradings covered the widest possible range, but they had one property in common; that is, a fineness modulus of 6.04. All specimens were mixed with the same quantity of cement and water. Separate sets of specimens were made of two different consistencies. The mean variation from the average strength is about 3 per cent.

Table II also furnishes some interesting data on the surface-area method of proportioning aggregates. It is seen that there is the widest variation in the surface area of the aggregate without any appreciable difference in the concrete strength. Our studies have clearly shown that surface area is not a satisfactory basis for proportioning aggregates.

Design of Concrete Mixes.—The problem of designing concrete mixes using given materials resolves itself into that of finding the combination which with a given water-ratio will give a concrete of suitable workability using a minimum of cement.

The following outline will make clear the steps to be followed in the design of concrete mixes on the basis of our studies of concrete:

STEPS IN THE DESIGN OF CONCRETE MIXTURES.

1. Knowing the compressive strength required of the concrete, determine by reference to Fig. 1 the maximum water-ratio which may be used. Subsequent steps in the design of concrete mixes are only devices for securing a workable concrete using this water-ratio and a minimum quantity of cement. It is obvious that a given water-ratio can be secured with a minimum of cement if the aggregate is graded as coarse as permissible (considering its size and the mix used) and if we use the driest mix which can be properly placed. Securing a coarse, well-graded aggregate, using rich mixes, employing the driest practicable consistency, using mechanical methods of placing concrete, etc., are all methods of producing a workable mix with a minimum water-ratio. Experience or trial is the only guide in determining the relative consistency of concrete necessary in the work. Obviously the driest workable consistency should be used.

The size of aggregate available, or which must be used, and the other factors will furnish a guide as to the mix. The mix is expressed as one volume of cement to a given number of volumes of aggregate; that is, the combined fine and coarse aggregate. In general, some allowance must be made for the high strengths in laboratory tests. In other words, a water-ratio somewhat lower than that given for the required strength in Fig. 1 should be used. For convenience in the subsequent steps we shall deal with concrete strength instead of water-ratio (as in Fig. 4), although it should be understood that it is the water-ratio which fixes the strength so long as we have a plastic mix.

2. Make sieve analysis of fine and coarse aggregates, using Tyler standard sieves of the following sizes: 100, 48, 28, 14, 8, 4, ⅜, ¾ and 1½ in. Express sieve analysis in terms of percentages

[illegible]

[illegible]

[illegible]

[illegible] Fig. [illegible]

[illegible]

[illegible]

where p = percentage of fine aggregate in total mixture.

[illegible]

[illegible] for making com[illegible] proportion of fine and [illegible] between fine and coarse aggregate is solely for convenience in securing a uniform grading; the division may be made at any desired point.

[illegible] modulus and consistency [illegible] strength of concrete produced by the combination. If the strength shown by the diagram is not that required, the necessary readjustment may be made by changing the mix, consistency or size and grading of the aggregates.

The quantity of water required can be determined from Formula 4 below, or approximately from Table V.

Important Note—It must be understood that the values in Fig. 4 [illegible] tests of 6 by 12-in. cylinders stored [illegible] days [illegible] place. The values obtained on the work will depend [illegible] factors as the consistency of the concrete, quality of the cement, methods of mixing, handling, placing the concrete, etc., and on age and curing conditions.

Strength values higher than given for relative consistency of [illegible] considered in designing, since it is only in [illegible] consistency drier than this can be satis[illegible] placed. [illegible] wetter concrete much lower strengths must be considered.

Calculation of Water Required for Concrete.—Because of the important influence of the quantity of water in the concrete it is desirable to have a sound basis for proportioning the water. The quantity of water necessary for given proportions and conditions may be determined by the following formula:

$$x = R\left[\left(\frac{3}{2}p + \frac{.30}{1.26^m} + a - c\right)n\right] \ldots\ldots (4)$$

where x = water required—ratio to volume of cement in batch (water-ratio).

R = Relative consistency of concrete, or "workability factor." Normal consistency (relative consistency = 1.00) requires the use of such a quantity of mixing water as will cause a slump of ½ to 1 in. in a freshly molded 6 by 12-in. cylinder of about 1:4 mix upon withdrawing the form by a steady, upward pull. A relative consistency of 1.10 requires the use of 10 per cent more water and under the above conditions will give a slump of about 5 to 6 in.

p = Normal consistency of cement, ratio by weight.

m = Fineness modulus of aggregate (an exponent).

n = Volumes of mixed aggregate to one of cement.

a = Absorption of aggregate, ratio of water absorbed to volume of aggregate. (Determined after immersion in water for 3 hours. Average values for crushed limestone and pebbles may be assumed as 0.02; porous sandstones may reach 0.08; very light and porous aggregate may reach 0.25.)

c = Moisture contained in aggregate, ratio of water contained to volume of aggregate. (Assume as zero for room-dry aggregate.)

This formula takes account of all the factors which affect the quantity of water required in a concrete mixture. These factors may be classified as follows:

1. "Workability" factor, or the relative consistency of the concrete. This is dictated by the kind of work being done; concrete must be more plastic (which generally means a wetter consistency) in reinforced concrete building construction than is necessary in mass work. The term (R) in the equation takes care of this factor. (R) may vary from, say, 0.90 for a dry concrete to 2.00 or higher for very wet mixes.
2. Cement factor, which is made up of two parts: the quality of cement so far as normal consistency is concerned (p); the quantity of cement in the mix (n).
3. The aggregate factor. This includes the three terms within the parenthesis in Equation 4. The first term, involving (m), takes account of the size and grading; the second (a) the absorption, and the third (c) the water contained in the aggregate.

In case admixtures of any kind are used, another term must be inserted in the equation. This relation has been fully worked out, but is not included in this report.

Simplified Water Formula.—While Equation (4) represents the true water relation, it is somewhat complicated by the fact that the fineness modulus (m) appears as an exponent. The equation can be expressed in a simpler form as follows:

$$x = R\left[\frac{3}{2}p + \left(0.22 + \frac{m}{42} + a - c\right)n\right] \ldots\ldots (5)$$

This equation gives values for ordinary ranges of mix and grading of aggregate which are sensibly the same as given by Equation (4).

Maximum Permissible Values of Fineness Modulus of Aggregates.—Since a maximum practicable value of fineness modulus is found for each size of aggregate and mix, it is necessary to place certain limits on the value which may be used for proportioning materials for concrete mixes. Table 3 gives limits which will be found practicable. Subsequent experience may dictate certain modifications in the details.

The purpose of Table III is to avoid the attempt to secure an aggregate grading which is too coarse for its maximum size and for the amount of cement used. It is also useful in prohibiting attempts to use sands which are too coarse for best results in concrete mixtures. For instance, it would be found from this table that the use of a sand of the nature of standard Ottawa sand is not permitted except in mixes 1:2 or richer.

TABLE III.—MAXIMUM PERMISSIBLE VALUES OF FINENESS MODULUS OF AGGREGATES

For mixes other than those given in the table, use the value for [illegible]

For maximum sizes of aggregate other than those given in the table, use the values for the next smaller size.

Fine aggregate includes all material finer than No. 4 sieve; coarse aggregate includes all material coarser than the No. 4 sieve. Mortar is a mixture of cement, water and fine aggregate.

This table is based on the requirements for sand-and-pebble or [illegible] of approximately spherical particles, in ordinary uses of concrete in reinforced concrete structures. For other materials and in other classes of work the maximum permissible values of fineness modulus for an aggregate of a given size is subject to the following corrections.

(1) If crushed stone or slag is used as coarse aggregate, reduce values in table by 0.25. For crushed material consisting of unusually flat or elongated particles, reduce values by 0.40.

(2) For pebbles consisting of flat particles, reduce values by [illegible]

(3) If stone screenings are used as fine aggregate, reduce values by 0.25.

(4) For the top course in concrete roads, reduce the values by 0.25. If finishing is done by mechanical means, this reduction need not be made.

(5) In work of massive proportions, such that the smallest dimension is larger than 10 times the maximum size of the coarse aggregate, additions may be made to the values in the table as follows: for ¾-in. aggregate 0.10; for 1½-in. 0.20; for 3-in. 0.30; for 6-in. 0.40.

Sand with fineness modulus lower than 1.50 is undesirable as a fine aggregate in ordinary concrete mixes. Natural sands of such fineness are seldom found.

Sand or screenings used for fine aggregate in concrete must not have a higher fineness modulus than that permitted for mortars of the same mix. Mortar mixes are covered by the table and by (3) above.

Crushed stone mixed with both finer sand and coarser pebbles requires no reduction in fineness modulus provided the quantity of crushed stone is less than 30 per cent of the total volume of the [illegible]

[illegible]	[illegible]													
Agg.	0-28	0-14	0-8	0-[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0-1 [illegible]	0-1½	0-2[illegible]*	0-3-in.	0-4½*	0-6 in.
1-12	1.20	1.80	2.40	2.95	3.35	3.80	4.20	4.60	5.00	5.35	5.75	6.20	6.60	7.00
1-9	1.30	1.85	2.45	3.05	3.45	3.85	4.25	4.65	5.00	5.40	5.80	6.25	6.65	7.05
1-7	1.40	1.95	2.55	3.20	3.55	3.95	4.35	4.75	5.15	5.55	5.95	6.40	6.80	7.20
1-6	1.50	2.05	2.65	3.30	3.65	4.05	4.45	4.85	5.25	5.65	6.05	6.50	6.90	7.30
1-5	1.60	2.15	2.75	3.45	3.80	4.20	4.60	5.00	5.40	5.80	6.20	6.60	7.00	7.45
1-4	1.70	2.30	2.90	3.60	4.00	4.40	4.80	5.20	5.60	6.00	6.40	6.85	7.25	7.65
1-3	1.85	2.50	3.10	3.90	4.30	4.70	5.10	5.50	5.90	6.30	6.70	7.15	7.55	8.00
1-2	2.00	2.70	3.40	4.20	4.60	5.05	5.45	5.90	6.30	6.70	7.10	7.55	7.95	8.40
1-1	2.25	3.00	3.80	4.75	5.25	5.60	6.05	6.50	6.90	7.35	7.75	8.20	8.65	9.10

*Considered as "half-size" sieves; not used in computing fineness modulus.

The curves in Figure 3 are platted directly from the values given for the standard sieves in Table III.

Chart for Design of Concrete Mixes.—Figure 4 is a nomographic chart for the design of concrete mixes. This chart takes account of the following four factors:

1. The mix (cement content).
2. The relative consistency.
3. The grading of aggregate (fineness modulus).
4. The compressive strength of concrete.

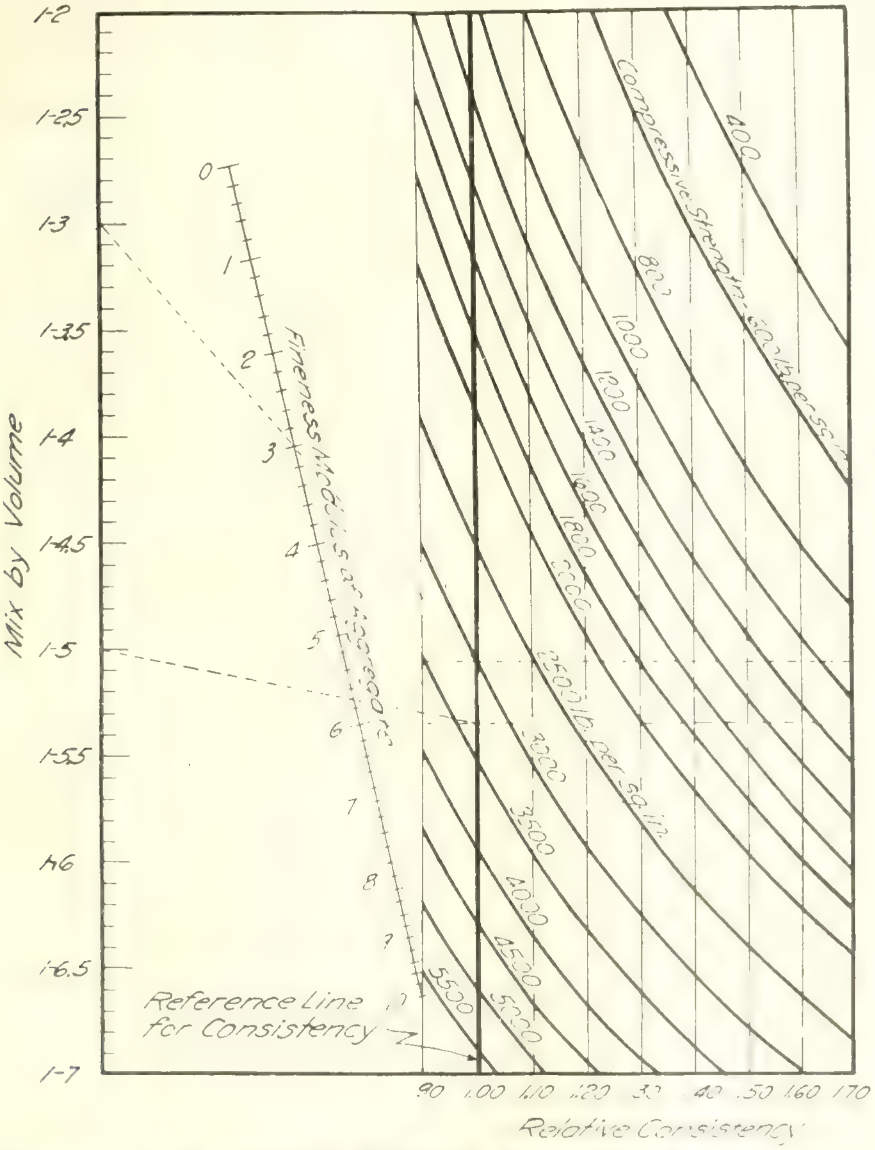


Fig. 4—Diagram for the Design of Concrete Mixtures.

This chart is based on compression tests of 6 by 12-inch cylinders; age 28 days, stored in damp sand. The cement used gave compressive strengths in 1-3 standard sand mortar as follows:

Age.	Lb. per sq. in.
7 days	1,900
28 days	3,200
3 months	4,200
1 year	4,300

Given any three of these factors the chart enables us to solve for the fourth. This chart is, of course, based on the results of certain tests. For practical application these values must generally be reduced by certain factors, which will depend on the judgment of the designer. In order to furnish some basis for comparison, compression tests of 1:3 standard sand mortars from the cement used in these tests are given.

Suppose we consider the case of concrete for road construction. This is generally specified as a 1:1½:3 or a 1:2:3 mix, with aggregate graded up to 1½ in. These mixes are about the same as what have been termed a 1:4 mix, the exact equivalent depending on the particular size and grading of the fine and coarse aggregate. Assume that gravel aggregate will be used, graded to 1½ in. Table III shows that we may use a fineness modulus as high as 6.00 — .25 = 5.75. Knowing the sieve analysis and fineness modulus of both sizes of aggregate, apply the formula or Fig. 5 to determine the proportions of each aggregate which must be mixed to a relative consistency of 1.10, which is of such plasticity as will give a slump of 5 to 6 in. in the test described above. Place a straightedge in Fig. 4 on Mix 1:4 and fineness modulus 5.75, and mark the point where it crosses the reference line for consistency; from this point project the line horizontally (as indicatd in other examples) to relative consistency 1.10. It will be seen that this gives a compressive strength of 3,400 lb. per square inch at 28 days.

The effect of using other mixes, gradings or consistencies on the strength can be seen at once from the diagram. For instance, if the water were increased to a relative consistency of 1.25 (not nearly so wet as is frequently seen in road work) the strength will be reduced to 2,700 lb. per square inch—a reduction of over 20 per cent. If the mix were changed to 1:14½ and other factors the same as in the first example, the strength would be 3,200 lb. per square inch. We should have to change the mix to as lean as 1:5¼ in order to secure the same reduction in strength as was found above for a change from 1.10 to 1.25 consistency.

By using the wetter of the two consistencies we secure concrete of the same strength as if we had used one-third less cement and the drier mix. In other words, increasing the mixing water 13 per cent causes the same reduction in strength as if we should omit 33 per cent of the cement. This example shows the reason for emphasizing the importance of proper control of mixing water in concrete.

This chart enables us to answer such questions as the following:

Which is the stronger, a 1:3 mortar or a 1:5 concrete mixture?

Assuming that concrete of the same plasticity is used, the relative strengths will depend, of course, on the grading of the aggregates and the mix. In one case we have assumed 1:3 mix with fineness modulus equal to 3.00. This will give a strength for normal consistency of 3,000 lb. per square inch. The 1:5 mix (fineness modulus 5.70) gives a strength for normal consistency of about 3,300 lb. per square inch. The strengths for other consistencies can be found by reading horizontally across the chart as indicated by the dotted lines.

Unfortunately, we now have no proper basis for absolute values for strength of concrete. This, of course, makes it necessary to refer to particular tests as in Fig. 4. This condition emphasizes the importance of working out a test of cement which will give us at once the concrete strength for given materials, mixes, etc. With the present method of testing cement it is impossible to do more than make a

TABLE IV—EXAMPLE OF INFLUENCE OF QUANTITY OF MIXING WATER ON THE STRENGTH OF CONCRETE.

Values calculated from equation

$$S = \frac{A}{B^x} = \frac{14{,}000}{8.2^x}$$

Where S = Compressive strength of concrete (lb. per sq. in.).
x = Water-ratio (an exponent).

A and B are constants whose values depend on quantity of cement and other conditions of the test. The values given for A and B are based on 28-day tests of 1:4 mix, pebble aggregate graded 0-1¼-in., fineness modulus 5.75.

The water ratio is equivalent to the cubic feet of water to 1 sack (1 cu. ft.) of cement.

The strength values are solely for comparative purposes in showing the influence of changing the water content.

Water in a 1-bag batch.		Relative consistency.	Compressive strength of concrete at 28 days.	
Gallons.	Water-ratio (x).	Per cent.	Lb. per sq. in. (S)	Relative strength. Per cent
5.75	.77	100	2,770	100
6.0	.80	104	2,600	94
6.25	.84	109	2,400	87
6.5	.87	113	2,250	81
7.0	.94	122	1,950	70
7.5	1.01	131	1,670	60
8.0	1.07	139	1,470	53
9.0	1.21	157	1,100	40
10.0	1.34	174	830	30
12.0	1.60	208	480	17
15.0	2.00	260	200	7

[illegible] of concrete from the results of briquet tests.

Quantity of Water Required for Concrete.—The formulas given above (4 and 5) show the elements which make up the water requirements of a concrete mix. Table V gives the quantity of water required for certain mixes and values of fineness modulus. Quantities are given in terms of gallons per sack of cement. In this table the net absorption (that is, the quantity of water taken up by the aggregate in addition to that already contained) is assumed as 0.02 (2 per cent by volume). This table is of interest when we consider that it has been found that a given water-ratio corresponds to constant concrete strength regardless of the combination of mix, consistency or grading of aggregate which may be used, so long as we have a workable concrete.

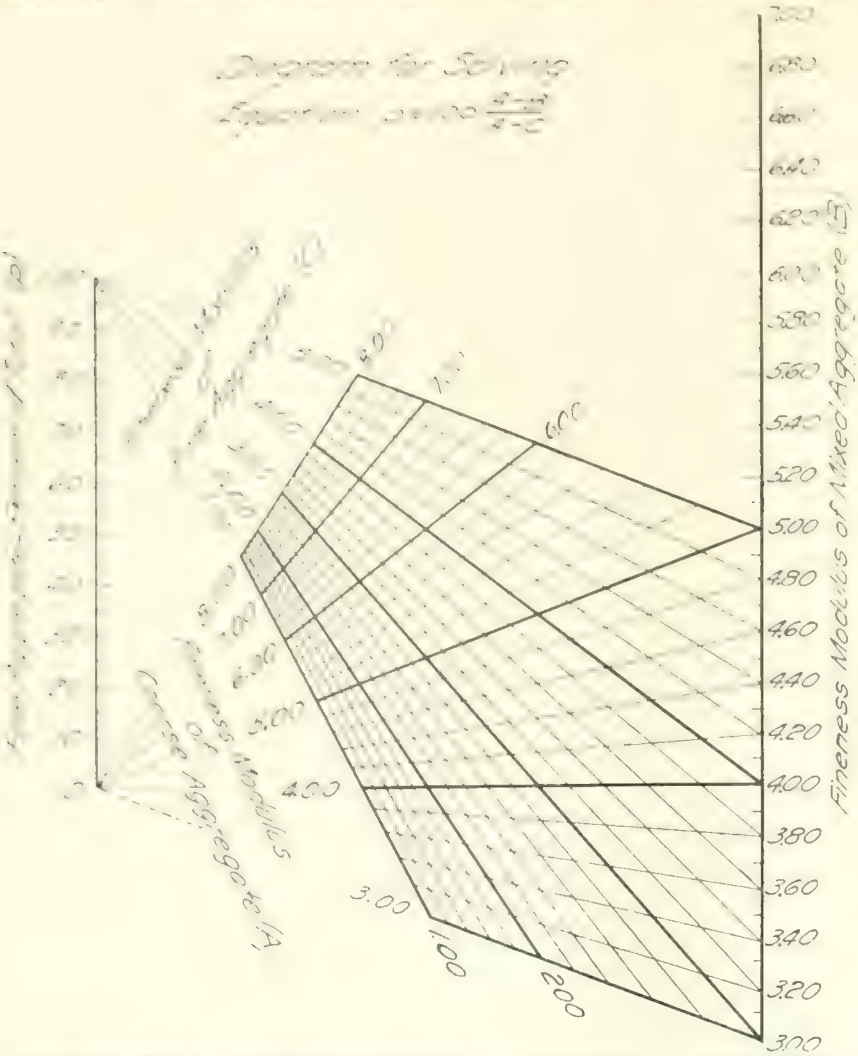


Fig. 5—Diagram for Determining Quantity of Sand Required in Concrete Mixes.

Based on equation $p = 100\,\frac{A - B}{A - C}$

where p = percentage of fine aggregate in total mixture.
A = fineness modulus of coarse aggregate.
B = fineness modulus of total aggregate.
C = fineness modulus of fine aggregate.

The dotted line D-E shows the method of finding the percentage of sand required to give a mixed aggregate with a fineness modulus of 5.75, using sand with a fineness modulus of 3.00 and a coarse aggregate with a fineness modulus of 7.00. [illegible] of sand mixed with 68 per cent of coarse aggregate gives the desired result.

Useful Accessories for Boiler Plants.—But little progress toward efficiency can be made in fire room practice unless data are available from which standards of performance can be established, stated Mr. Alfred O. Doane, Division Engineer of the Metropolitan Waterworks, in a paper before the New England Waterworks Association. Such information must be obtained largely by means of scales, meters, gages and other devices of like nature. All but the very smallest instalations should be provided with scales for weighing coal, and one or more water meters to measure the boiler feed water so that the quantity of water evaporated per pound of coal and the cost of making steam may be ascertained. Larger plants should have thermometers for indicating the temperature of flue gases, of the passes in water tube boiler settings, and of feed water before and after passing through heaters; draft gages for indicating pressures in flues and furnaces, or a combination gage showing the difference in pressure between the furnace and the flue. Recording steam gages are very useful and form one of the best checks on the faithfulness of the fire room force. The boiler rooms of large modern power plants are generally equipped with steam flow meters, sometimes both on mains and individual boilers, CO_2 indicators, and other elaborate, complicated and costly apparatus. Some of these instruments, notably the various forms of CO_2 indicators, require expert attendence which is far beyond the capabilities of the average fireman.

TABLE V.—QUANTITY OF MIXING WATER REQUIRED FOR CONCRETE.

Calculated by formula: $x = R\left[\frac{3}{2}p + \left(\frac{.30}{1.26^m} + a - c\right) n\right]$

Where x = Water required—ratio to volume of cement in batch (water-ratio).
R = Relative consistency, or "workability factor." Where R = 1.00 the concrete is said to be of "normal consistency."
p = Normal consistency of cement by weight (assume [illegible]).
m = Fineness modulus of aggregate.
n = Volume of mixed aggregate to one volume of cement.
a = Absorption of aggregate, ratio of water absorbed to volume of aggregate.
c = Moisture in aggregate, ratio of water contained to volume of aggregate.
(a — c) = Net absorption of aggregate by volume.

In this table (a — c) is assumed as 0.02. In other words the net quantity of water taken by the aggregate is 2 per cent by volume. [illegible] limestones and pebbles [illegible] somewhat high. It is too high in any case where the aggregate is saturated with water.

A relative consistency of 1.00 (normal consistency) requires the use of such a quantity of mixing water as will cause a slump of ½ to 1 in. in a freshly molded 6 by 12-in. cylinder of about 1:4 mix upon withdrawing the form by a steady, upward pull. This consistency is somewhat dry for most concrete work, but can be used where light tamping is practicable.

A relative consistency of 1.10 (10 per cent more water than required for normal consistency) represents about the driest concrete which can be satisfactorily used in concrete road construction. Under the conditions mentioned above, this consistency will give a slump of about 5 to 6 in.

A relative consistency of 1.25 represents about the wettest consistency which should be used in reinforced concrete building construction. Under the conditions mentioned above, this consistency will give a slump of about 8 to 9 in.

For mixes and fineness moduli, other than those given in the table, approximate values may be determined by interpolation. For specific cases use the formula.

Mix. cem.-agg. by volume.	Gallons of water per sack of cement. Using aggregates of different fineness moduli. 1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00
	Relative consistency — (R) = 1.00.											
1-12	23.5	21.4	19.5	17.8	16.4	15.2	13.9	12.9	12.0	11.1	10.4	9.8
1-9	18.1	16.7	15.2	14.0	12.9	12.0	11.0	10.2	9.6	9.0	8.4	7.9
1-7	14.7	13.5	12.3	11.4	10.6	9.9	9.1	8.6	8.0	7.6	7.2	6.7
1-6	13.0	12.0	11.0	10.2	9.5	8.9	8.3	7.7	7.3	6.8	6.5	6.2
1-5	11.2	10.4	9.5	8.9	8.3	7.8	7.3	6.9	6.4	6.1	5.8	5.5
1-4	9.5	8.9	8.2	7.7	7.2	6.8	6.3	6.0	5.7	5.4	5.2	5.0
1-3	7.8	7.2	6.7	6.3	6.0	5.7	5.4	5.1	4.9	4.6	4.5	4.3
1-2	6.0	5.7	5.4	5.1	4.9	4.7	4.5	4.3	4.1	4.0	3.9	3.8
1-1	4.3	4.1	3.9	3.8	3.7	3.6	3.5	3.4	3.3	3.2	3.2	3.1
	Relative consistency — (R) = 1.10.											
1-12	25.8	23.6	21.4	19.6	18.1	16.7	15.3	14.2	13.2	12.2	11.4	10.8
1-9	19.9	18.4	16.7	15.4	14.2	13.2	12.1	11.2	10.6	9.9	9.2	8.7
1-7	16.2	14.9	13.5	12.5	11.7	10.9	10.0	9.5	8.8	8.4	7.9	7.4
1-6	14.3	13.2	12.1	11.2	10.5	9.8	9.1	8.5	8.0	7.5	7.2	6.8
1-5	12.3	11.4	10.5	9.8	9.1	8.6	8.0	7.6	7.0	6.7	6.4	6.1
1-4	10.5	9.8	9.0	8.5	7.9	7.5	6.9	6.6	6.3	5.9	5.7	5.5
1-3	8.6	7.9	7.4	6.9	6.6	6.3	5.9	5.6	5.4	5.1	5.0	4.7
1-2	6.6	6.3	5.9	5.6	5.4	5.2	5.0	4.7	4.5	4.4	4.3	4.2
1-1	4.7	4.5	4.3	4.2	4.1	4.0	3.9	3.7	3.6	3.5	3.5	3.4
	Relative consistency — (R) = 1.25.											
1-12	29.4	26.8	24.4	22.2	20.5	19.0	17.4	16.1	15.0	13.9	13.0	12.3
1-9	22.6	20.9	19.0	17.5	16.1	15.0	13.8	12.7	12.0	11.2	10.5	9.9
1-7	18.4	16.9	15.4	14.3	13.2	12.4	11.4	10.7	10.0	9.5	9.0	8.4
1-6	16.3	15.0	13.8	12.8	11.9	11.1	10.4	9.6	9.1	8.5	8.1	7.7
1-5	14.0	13.0	11.9	11.1	10.4	9.8	9.1	8.6	8.0	7.6	7.2	6.9
1-4	11.9	11.1	10.2	9.6	9.0	8.5	7.9	7.5	7.1	6.8	6.5	6.2
1-3	9.8	9.0	8.4	7.9	7.5	7.1	6.8	6.4	6.1	5.8	5.6	5.4
1-2	7.5	7.1	6.8	6.4	6.1	5.9	5.6	5.4	5.1	5.0	4.9	4.8
1-1	5.4	5.1	4.9	4.8	4.6	4.5	4.4	4.3	4.1	4.0	4.0	3.9

Standardization of Details for School Buildings

Standard details of features which occur repeatedly in different school buildings are employed by the Drafting Division of the Bureau of Design, Construction and Maintenance of the Board of Education of New York City, in preparing plans for new structures. The drawings are made on tracing cloth. While these standard details do not entirely obviate the necessity for special details they do reduce the number of the latter to a minimum. The advantages of these standards are: First, the entire subject is very thoroughly studied when the standard is prepared and the detail is made to cover every phase of the construction, so as to furnish all the information required on that subject. Second, the draftsmen become familiar with the standards and are able to proceed with the plans much more expeditiously. Third, the contractors after becoming familiar with them, are able to systematize their methods of production and to reduce their estimates accordingly.

The Division has at the present time about 100 standard details covering practically every feature of the building from column bases to the flagpole on the roof. A complete file of these is furnished to each squad leader and each is required to plan his work in conformity with them as far as practicable.

The plan production methods of the Board of Education of New York City were described by Mr. Clarence E. Dobbins, Deputy Superintendent of School Buildings, in charge of General Drafting Room, in a paper presented recently before the municipal engineers of the city of New York. An abstract of this paper was given in our March 26 issue.

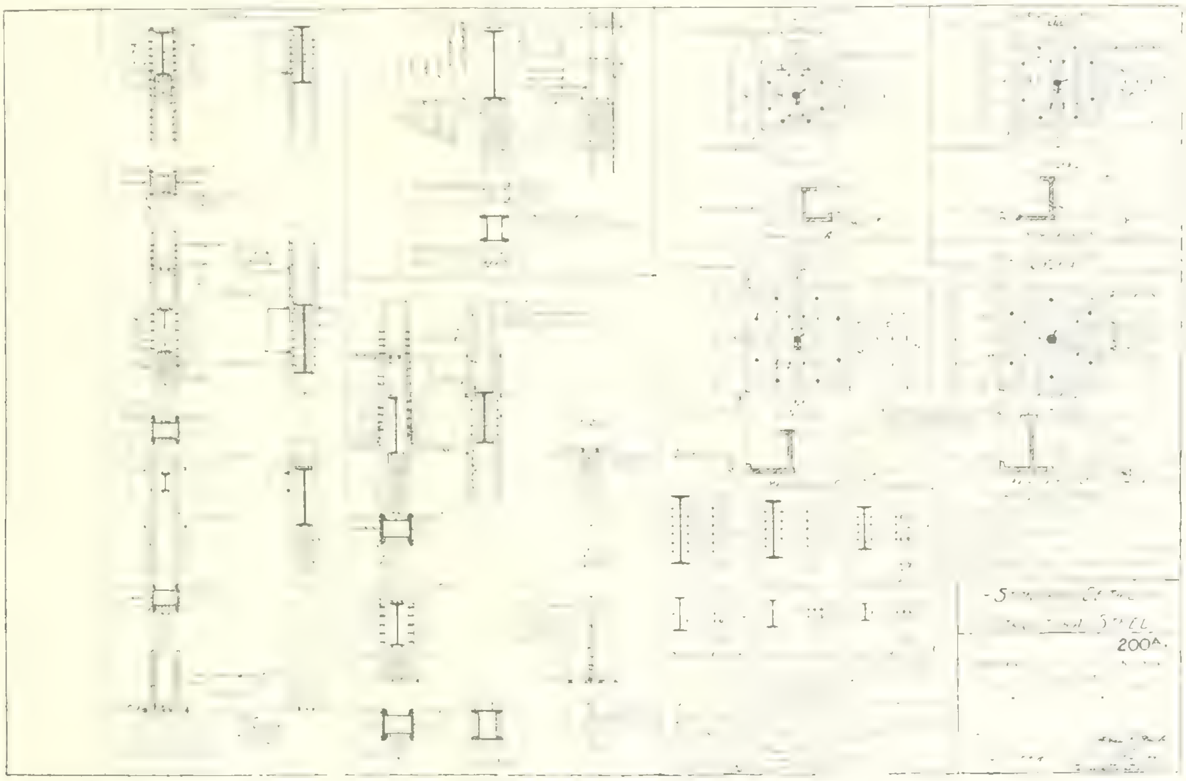
Examination for Highway Bridge Engineers.—Civil service examinations will be held to secure highway bridge engineers at $1,800 to $2,100 per year, and junior highway bridge engineers at $1,200 to $1,600 per year, for the Bureau of Public Roads and Rural Engineering. Information can be obtained from the U. S. Civil Service Commission, Washington, D. C., or from local offices of the Comission.

Conference on City Planning.—The 11th annual city planning conference will be held May 26-28 at Niagara Falls and Buffalo, N. Y. Flavel Shurtleff, 19 Congress St., Boston, Mass., is Secretary of the Conference.

Empirical Column Formulas for Brick Piers

Under the direction of the Building Department of Toronto, Canada, a series of tests on the absorption, strength in compression and bending of brick, and strength of brick piers, has been made recently. The results were outlined by Mr. W. W. Pearse, City Architect, in a paper presented Feb. 7 before the Building Officials' Conference of the United States and Canada and the National Brick Manufacturers' Association of the United States.

The brick selected were not the best brick manufactured, but were of the type usually used as backing brick. It was found that absorption affected the strength of brick in compression. Brick having an absorption of 12 per cent and under were on an average of about 38 per cent stronger in compression and 85 per cent stronger in bending than the average brick absorbing more than 12 per cent of moisture. In determining the modulus of rupture, a center load with 7 in. between supports was supplied. Both lime and cement mortar was used in the piers and cubes of mortar, 6 in. on a side, at an age of approximately three months, were tested. The results of these tests are as follows:



Standard Detail for Structural-Steel Work. Covering All Ordinary Conditions for Columns, Column Bases and Connections for Beams and Girders. Special Details Are Required Only for Plate Girders, Trusses, Etc.

Modulus of rupture of individual brick, 165 lb. per square inch.

Crushing strength of undivided brick, 1,000 lb. per square inch.

Crushing strength of lime mortar (1 part lime, 3 parts sand), 235 lb. per square inch.

Crushing strength of cement cubes (1 part portland cement, 3 parts of sand, and ¼ part hydrated lime by volume), 1,835 lb. per square inch.

To arrive at a relation between the individual brick and brick laid up in press, a poor type of brick was selected and built into 14 piers of different heights. The piers were laid up, some in lime mortar, some in cement, by an experienced bricklayer. They were 8⅝ in. square in plan and were built so as to represent a portion of an ordinary brick wall one brick thick bonded by headers every sixth course, according to common practice in Toronto. No effort was made to obtain a class of workmanship better than would be expected from men of ordinary skill. Each pier was built on a plate of ¼-in. steel, 13 in. square, as a base and capped with plaster of Paris. The piers were allowed to set for a period of about three months before testing.

A course of bricks including mortar joint averaged [illegible]

In [illegible] the [illegible] strength and [illegible] Values of [illegible] in [illegible] were [illegible] from [illegible]. In addition to the crushing strength of each pier, the amount of [illegible] and the lateral deflection, if any, were recorded.

Figure 1 gives the results of the tests on the piers and the [illegible] of the curves [illegible] the plotted results. From the stress-strain curves [illegible] of resilience of the [illegible] to the [illegible] were deduced with the following average results:

Piers laid with cement mortar, [illegible] ft.-lb. per cubic foot.

Piers laid with lime mortar, [illegible] ft.-lb. per cubic foot.

The resilience or [illegible] per cent greater where cement mortar is used than where lime mortar is employed. The average strength in compression of the cement mortar series exceeded the strength of the lime mortar series by practically [illegible] per cent.

The general conclusions from the tests can be summarized as follows:

1. The strength of the strongest pier laid in cement mortar was 78 per cent of the strength of the individual brick.

2. The strength of the strongest pier laid in lime mortar was 55 per cent of the strength of the individual brick.

3. Brick masonry laid in cement mortar is about 50 per cent more rigid and 60 per cent stronger than that laid in lime mortar, and the resistance to shock is 60 per cent greater in the former than the latter.

4. Longitudinal or vertical rupture through bonding courses occurred very ferquently.

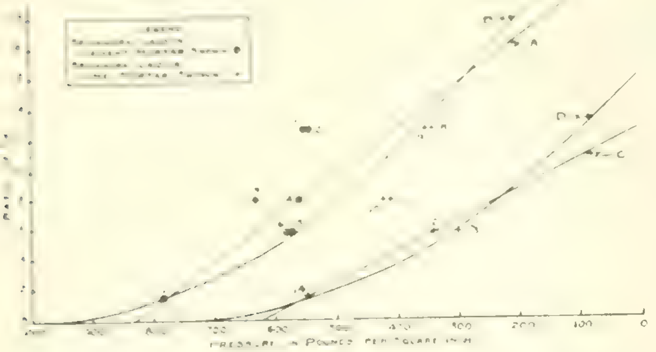


Fig. 1—Formulas for Strength of Brick Piers.

[illegible] P = 620 − 50 l/d
[illegible] P = 760 − 100 l/d
l = length of pier in inches
d = least thickness of pier in inches

5. No appreciable shrinkage in height could be observed during the first month after construction. After this period, measurements were discontinued.

6. Lateral deflections under load were in most cases so small as to be almost incapable of measurement with a scale divided into 100th of an inch.

The tests were made at the University of Toronto under the direction of Peter Gillespie, Associate Professor of Applied Mechanics, who proposes the following formulas for the strength of brick piers in pounds per square foot, derived directly from formulas A and C, Fig. 1:

$P = 110{,}000 - 3{,}000\ l/d$ for cement mortar.
$P = 80{,}000 - 3{,}000\ l/d$ for lime mortar.

The formulas differ from those suggested in Technologic Paper No. 111 of the U. S. Bureau of Standards (Engineering and Contracting Nov. 27, 1918), in that they take into account the slenderness ratio of the pier, an obvious factor in the strength of piers.

Examination for Bridge Designers.—The New York State Civil Service Commission, Albany, N. Y., will hold an examination to fill vacancies in the position of bridge designer with the Public Service Commission for the First District. Salaries range from $1,500 to $2,100 per year. Applications must be filed before May 24.

The Architect As a Business Man and His Relation to the Engineer*

For a long time I have believed that the architect has had the wrong point of view in considering himself purely as a professional man and in arrogating to himself a position in society beside the recognized professions, such as medicine and the law, and in trying to place himself in much the same category with painters, musicians and sculptors.

The architect's work is not personal in the manner of the work of those with whom he seeks to class himself. When the painter has completed a canvas; when the writer has set down the last word of his manuscript; when the composer has placed the last hieroglyphic on his score, he is finished. It may be, as in the case of the composer, that his ideas must be expressed in another medium than he used in recording them, but a musical composition is performed directly from the composer's score and the performances may be repeated in all their pristine freshness of inspiration long after the composer himself has "gone west." That, however, is merely a matter of method imposed by the very nature of the art of music.

When the work of an architect reaches the stage attained by a composer upon the completion of a musical score, he may be said only to have commenced. Up to that point, the architect's work has been largely intellectual. It has been concerned with the academic solution of the particular problem, with matters of design, with the preparation of highly technical drawings, highly technical specifications, etc. Up to this time, the architect may be said to work much in the manner of the attorney who seeks a legal solution of a given legal problem and then embodies his conclusions in a legal brief. At this stage the lawyer may be said to have completed his work, but not so the architect.

Because of the necessity of dealing with business agencies before his ideas may be expressed in physical forms, the position of the architect in the scheme of things differs fundamentally from that of the physician, the attorney, the writer, the dramatist, the poet, the sculptor, the musician.

On the other hand, the architect cannot be allied with the exponents of the various industrial arts. Lighting fixture manufacturers, furniture manufacturers, silver and goldsmiths stand on the same plane with architects in matters of design. In fact, some of them produce works that in genuine inspiration, individuality and skill are more really akin to the work of the true artist than is the work of very many of the most eminent architects. But these artificers, cunning and skillful as they are, do not sell a "service"; they market a finished product.

The architect will find his "place in the sun" only when he understands thoroughly the nature of the service he should render to society. More than anything else, his position is that of a trust officer.

A client places in the hands of his architect a sum of money. The architect is asked to expend this sum for the client in the creation of a building in which the client may conduct his business more economically or efficiently, or in which he may live in greater comfort, or out of which he may derive an income, or by means of which the health or convenience of the public may be conserved.

No man in his sober senses would place any part of his own estate, or the estate of another in the hands of a trust company the officers of which were notorious for iridescent financial dreams but criminally lacking in judgment regarding the value of investments.

No man in his sober senses should place any of his money in the hands of an architect, for investment in building construction, if the architect is able only to produce clever and enticing things on paper and lacks the business organization for translating them efficiently into terms of building.

The architect who does not surround himself with a business organization, who does not know business methods, who is unfamiliar with building costs, who is not skilled in buying, as the agent of his client, and who does not obtain for his client the best quality of buliding construction at the proper price is not discharging his whole duty to his client. He is a menace to society and he should be restrained from practicing independently.

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*From an address by Oscar Wenderoth, formerly Supervising Architect of the Treasury Department and now associated with the Weary & Alford Co. of Chicago, in Architecture and Building.

The autocratic attitude of the architect is undoubtedly due to the fact that for years he has been trained to believe that when he has conceived an academic solution of a problem everything else is of minor importance. Obsessed with this idea of superiority, the architect assumes a contemptuous attitude towards all matters of business, towards contractors, towards engineers, and may even place but little value upon the technical adequacy of his own working drawings and his own specifications.

That this autocratic attitude brings its own punishment is commencing to become evident. Owners are going to "others who build better, more efficiently and more economically under the name of architectural or engineering contracting firms." This the architect has brought upon himself.

There is much fine architecture produced in this country, and a large proportion of it is done by individuals and firms with enviable reputations—in the "profession." We think of these individuals as acquiring their reputations and their large practices solely through the architectural quality of their work. But if we analyze the situation, we find that such is not the case. The architects who stand highest are as keen "business getters" as is anyone else. They do not advertise directly—yet—and they may avoid unregulated competitions as much as possible, but they seek work by means of personal and social connections to an extent that would make a reputable physician blush with shame. But the architect has been forced to adopt these devious methods of obtaining work because he has thought it necessary to hide behind a thin camouflage of alleged "professionalism," which prevents him from seeking employment openly. When, however, the architect realizes that his service to his client must rest upon a firm foundation of business efficiency he will be able to approach the client from that angle and he will obtain work because of what he can do rather than because of the number of friends he has.

The offices in this country that have great architectural reputations do not exist solely because of the quality of their architectural work. They survive, first, because they are business getters—regardless of their devious method of obtaining work—and, second, because in each such organization there is a "power behind the throne." The "power" is usually the engineer! He has an understanding of and an appreciation of matters architectural because he is educated and a—gentleman. This is the chap who prevents the "long-haired" contingent from sending the concern on the rocks He is looked down upon somewhat because he is engaged in such sordid activities as directing the business end, managing the office at a profit, discussing business matters with clients, checking bids and estimates, directing the specification writing, passing upon engineering and structural matters, adjusting costs with contractors and doing quietly the things that to the client represent the really valuable part of the architect's service.

It is desirable, of course, that the client should appreciate the purely architectural worth of the architect's service, because the future of the "art" side of architecture in this country depends upon the intelligent encouragement of the architect by the client—as a patron—but, after all, the thing that touches the client closest is the manner in which the architect spends his, the client's money, and the value obtained for it.

The business of architecture today is doubtless more complicated than any other activity. The architect's office is a sort of department store, dealing in miscellaneous service instead of in miscellaneous merchandise.

The matter of architectural design is a profession in itself. A knowledge of the theory of design and the experience necessary to apply this knowledge to the solution of actual problems is as much as any one man can master in the short span of a lifetime—and many of us do not proceed very far along this difficult road, at that. But the capable designer—the man whose work can be used—must have a working knowledge of the characteristics of materials. In addition, he is required to be familiar with color in design, with ornament, etc. He must know the industrial arts in order that he may select intelligently the lighting fixtures, the rugs, the furniture, the hangings, etc., that will best compose with his own work.

But these academic matters are not the sum total of the architect's service.

If he succeeds, his organization must be able to obtain business. Somebody must be a salesman, whether he resents being known as such or not. If there is no salesman in the organization, the service of the organization will not be marketed.

In the development of the working drawings and specifications the architect is assisted by men who, with the exception of a very few, are chosen because their mental bias does not incline them towards architectural design, per se. These are the "job captains" who must have executive ability and must know how all kinds of materials used in building construction are combined in order that they may be intelligently indicated on the drawings, and these are the men who must know all about qualities of materials, sources of supply, etc., in order that they may include in the specifications the information that may not be placed on drawings.

Then there is the engineering contribution, none of which has anything whatever to do with considerations of architectural design. This work calls for a very high order of skill and intelligence, and let it be noted here that the "big" engineers display in their work the same qualities of imagination—the same creative instincts—that make for distinction in the work of the "big" architects.

Then there are all the dealings with contractors. I understand that there are some two hundred trades that, in one way or another, contribute to the various classes of building construction for which the architect prepares designs. To each one of these businesses a man will devote the study of a lifetime and then only become versed in one phase of it. But the architect must have some familiarity with all of these things.

But a wide knowledge of the distribution of building materials and building products does not in itself give a man the ability to deal successfully with building contractors and the manufacturers of building products. That is a matter of business and demands a knowledge of business relations. It is an executive rather than a technical function.

The direction of the construction of a building "in the field" is not an artistic matter, save for the passing upon carving, colors, textures, etc., and this is done by most busy architects in the office—many of them, in fact, never actually see the buildings that are erected at any considerable distance from their offices. Capable superintendence is a thing in itself. A man may be a good job captain, may write a fine specification or may direct the business details of a considerable operation and yet may not be able, for the life of him, to tell whether a certain batch of concrete is or is not being mixed properly.

The architect does considerable bookkeeping in connection with his clients' accounts, with payments to contractors, with extras, credits, etc., and if he is to keep things straight this work must be managed as carefully as it is in any business office.

In matters of correspondence, adjusting controversies, making final settlements, dealings with clients, etc., etc., the architect discharges a business function that, in essence, is no whit different from the business function of the despised contractor—except that the latter probably does these things much more intelligently and effectively.

There is no one man living and there never will be a man born who, of himself, can do all these things. I do not believe that any architect ever tried to persuade himself that he could do all of them. The trouble is that he has been compelled to think of himself as a professional man doing a personal thing. The result is that he places an importance upon the particular element of his service in which he has skill and considers everything else as subordinate and immaterial.

If it is true that no living being could render with uniform skill all the kinds of service that, together, make up the contribution of the architect, it necessarily follows that the complete service may only be offered by a number of men working together, each one contributing an important and necessary, but different, element.

Such a group must be made up of a business getter, a master of architectural design, a structural engineer, a mechanical engineer (heating, ventilating, sanitation), an electrical engineer, a business administrator and a technical director. An organization thus constituted is a business [illegible] a per- sonal and professional [illegible]

[illegible] with [illegible] that the great bulk [illegible] It is a business [illegible] is really the [illegible] although most conspicuous.

That architectural design is the least weighty element in [illegible] of architect- [illegible] without using [illegible] that the complete [illegible] and they succeed because of the value to their clients of the things that they actually do furnish.

[illegible] who has an efficient [illegible] as a "business proposition," who administers the work of construction adequately, [illegible] and who keeps measurably within his client's limit of cost will build up a large and well-paying "practice" with the least possible expenditure of thought on matters of academic design. And such a man earns all of the considerable sums he is paid because he "delivers" goods that have value.

[illegible] great talent and may be highly trained in matters of pure design and may starve in a garret because he has neither the necessary business qualities for success nor the sense to connect with the right people.

After all, it is success we all are aiming for. What good does it do a man to have great talent if he is given no opportunities for exercising it? And in architecture, above everything else, the opportunities for doing big and interesting things depend almost entirely upon "getting the business."

The architect today who is trying to impress his client with the idea that he, the architect, is engaged in personal and professional work is constantly playing a heart-breaking game of bluff. Instead of telling the client frankly that he is but one—though perhaps the principal—member of an organization that is offering the client a very complete service, he must try to impress the client with the belief that he is the "whole thing." So he keeps his associates in the background, for to admit that their contribution was as essential as his would destroy the air of professionalism and of personal service that a mistaken theory requires him to try and maintain. So he bluffs and bluffs, making wild guesses now and then, until finally he is found out.

One cannot conceive of a man engaged in true professional work having about him an organization such as is absolutely necessary to the architect if the latter is to discharge fully his obligation to his client and to the community. No professional man would undertake to do a number of things in most of which he had no skill. Such a professional man would be set down immediately as a charlatan because he would be operating a business under the guise of a profession.

Plenty of instances of similarity may be found between the organization of the architect's ideal office and the organization of business institutions, but none whatever can be discerned between the organization of such an office and a professional establishment. The reason, to reiterate, is that the architect's relation to society is that of a business man and not that of the professions.

The ideal organization for an architect should be a corporation. This form tends to stability. Each head of a department is a stockholder and the interests of the corporation are his interests also. Such an organization tends to inspire confidence in the mind of the client.

An architect may, of course, gather around him men who work with him congenially and who add to his contribution the things necessary to the complete service to which the client is entitled. The minor employes, of course, go and come, but when all the principals except the head hold positions that are subject to similar mutations there necessarily exists an element of weakness in the organization. An organization in which the directing personnel changes frequently can never become well knit and effective. It is only when the directing heads are part owners and have a say in the business policy and management—to the extent of their [illegible] and have also, a say in the important matter of hiring and firing that they become wedded to the particular business and give it their best efforts.

These are the signs of the times. If the architects are to hold their own they must understand that before everything else they must be effective business men; that their organizations must be founded upon business principles; that it does not suffice to produce fine "paper architecture" and to ignore or subordinate all the other elements in the service to which the client is justly entitled; that they must cease to worship the fetish of "professionalism," and they must cease to pose as self-contained individuals rendering an exclusive personal service.

The only way the architects can meet the new situation and save themselves is to change their point of view, reorganize as business institutions and by building better, more economically and more efficiently try to meet the growing competition of the "architectural and engineering contracting firms" that already are taking work away from them.

Form Work for Warehouse, Boston Army Supply Base

Remarkable progress was made in the construction last year of the main warehouse of the Army Supply Base at Boston. This building is 1,638 ft. long by 126 ft. wide and 8 stories. The superstructure contains 90,000 cu. yd. of reinforced concrete. Work on this was started by the general contractor, the W. F. Kearns Co., on May 24 and was completed on Oct. 2, 59 days ahead of construction, a total of 108 working days. An average of 900 cu. yd. of concrete was poured per day. Two construction towers, served by independent concrete mixers, distributed concrete to each section of building. The building consists of six sections—each 273 ft. long—in a continuous succession, individual sections being separated from their neighbors by a construction joint extending entirely through the cross-section except for the footings, which are common for the two abutting building columns. The first floor is designed for a live load of 500 lb. per square foot, and all subsequent floors for 300 lb. per square foot. All reinforced concrete designs are in accordance with the requirements of the so-called Joint Committee rules. The column spacing is 21 ft. by 21 ft., and all floors are of the flat slab type. The first story is 18 ft. in height, and subsequent stories are 14 ft. A twin tunnel runs the entire length of the building under the first floor, for the accommodation of steam pipes, electric conduits, etc.

An interesting feature of the construction, and one which greatly facilitated progress, was the system of forms used, especially that for floor slabs. The contractors studied their form work very carefully and instituted very successfully two radical changes in the usual method of form building. These changes and the form method were described by Mr. William F. Kearns of William F. Kearns Co., in a paper presented before the Boston Society of Civil Engineers, from which the matter following is abstracted.

A study of the difficulties involved in the foundation work of the warehouse revealed the fact that there probably would be three to four weeks between the completion of the caisson work on the first and second sections, and at least three weeks between the second and third, and so on through the remaining sections, the interval being cut down, as the work developed over more area, never getting less than a week or 10 days. Taking advantage of this construction feature, the contractors built a complete set of forms for every floor in Section A; then, in the interval, before the next section was ready, they stripped the completed section and moved the forms horizontally to the same floor of the section ready to be formed.

By working this way, they eliminated rebuilding the form work, as would have had to be done to meet the various requirements of the different floors if the forms had been moved up, and saved the cost of the labor that would have been necessary for such movement; and, in addition, there was a saving of at least 1,000,000 ft. of lumber.

The second change was necessitated by the confined working space at the site of the building. On account of this, it was necessary to construct all the forms at a central mill, and distribute them to the work complete in every detail, so that the men on the buildings were merely erectors, in fact, the fabrication and erection of all the form work was handled exactly as is structural steel in a building or bridge.

The forms were marked at the mill where they were fabricated, to correspond with the key or erection plans prepared by the contractors form-design department. Columns carrying the mark "C" and their designating number; beams, "B," beam bottoms, "BB," etc. Thus when the forms were delivered at the job, a glance at the key plan told the foreman exactly where the pieces were located, and a very small organization kept the mill constantly informed just what was wanted at each particular part of the job, so that pieces not needed for some little time were not lying around and going astray. In addition, this system of form handling avoided all confusion in moving the forms from one section to another, as typical pieces carried the same mark through the entire construction. Therefore it made no difference from what part of some other building a foreman secured his form, if it carried the marking of the piece he wanted, it fitted his work. Then again, in case a piece was destroyed in stripping, the mill was notified of the number of the piece, and a new one was made and sent to the work.

In the design of the form work, the contractors used the same method of flat slab centering which they found very economical in the previous experience. The typical floor frame consists of wooden mats 2 ft. 6 in. wide by 12 ft. long, made up of 2 by 3's placed 5 in. on center and covered with 20-gage black sheet steel. These mats are supported on 4 by 6 girts approximately 5 ft. on center and the girts held up by 3-in. by 4-in. posts, 5 to 6 ft. on center, according to requirements of the work.

This type of framing, if well made up so as not to be racked and twisted when stripped, can be used at least 10 times, and the sheet metal which is rolled after each usage is good for 12 to 15 uses. The exterior column forms were constructed of 2-in. spruce plank, and special care was used in their fabrication so that the forms would be extra strong; and with very few exceptions, these forms were used in all the sections of the warehouse, making in all about six times that they were set up.

Prices of Common Brick for 27 Year Period

Th following tabulation compiled from the files of the Record and Guide shows the average prices of North River common brick (good quality) for the period 1887-1914, at docks f. o. b. New York City:

Year.	Av price per M.	Year.	Av price per M.
1887	$6.45	1901	[illegible]
1888	5.50	1902	5.06
1889	6.06	1903	[illegible]
1890	5.69	1904	[illegible]
1891	4.90	1905	[illegible]
1892	4.71	1906	[illegible]
1893	4.98	1907	[illegible]
1894	4.50	1908	5.27
1895	4.95	1909	[illegible]
1896	4.75	1910	5.84
1897	4.53	1911	[illegible]
1898	5.29	1912	[illegible]
1899	5.45	1913	6.70
1900	4.69	1914	[illegible]

Patents on Flat Slab Construction.—In a suit brought by the Condron Co., Chicago, for infringement of the Sinks patent on "2-way" flat slab construction, an opinion was handed down on April 16, 1919, in the U. S. District Court, Northern District of Illinois, Eastern Division, by Judge A. L. Sanborn, which concludes as follows:

"The patentee may have made a better flat slab or shallow beam construction than prior inventors, but the patent itself, apart from simplifying computation, simply proceeded along lines suggested by engineering skill. I think the patent is invalid and that the bill should be dismissed."

The Condron Co. has announced that pending a decision on this case in the U. S. Court of Appeals, it will make no royalty charges to its patent licensees or to those who accept licenses from it for the use of the Sinks invention in flat slab buildings erected or contracted for between April 30, 1919, and the date of such decision, regardless of whether the decision, on appeal, sustains the Sinks patent or not.

The Objects of Structural Engineering Courses*

By HALBERT P. GILLETTE

Editor, Engineering and Contracting.

The writer is in full accord with Mr. Henry J. Burt's outline of the objects of structural courses. Particularly should emphasis be placed upon his statement that "it devolves on the teachers not only to prescribe the studies to be pursued during the college period, but to so train the student that he will continue in a progressive channel" after graduation.

As an editor of a civil engineering periodical, the writer has long been impressed by the fact that a large percentage of civil engineers do relatively little reading of any engineering periodicals. Whenever the writer goes to the library of an engineering society he notes what a pitifully small number of men are usually studying either periodicals or books. When he talks with practicing engineers, he finds that most of them excuse their ignorance as to recent developments in engineering, design and construction on the ground that they have been "too busy to keep up with the literature of the subject." When he sees that the total subscription lists of all the civil engineering and contracting periodicals combined do not include more than half the possible subscribers he is astounded.

The bald fact is that the majority of civil engineers cease to be real students of civil engineering shortly after they graduate. This being so (and sixteen years' editorial experience on the two leading civil engineering periodicals has shown the writer that it is so) there are but two explanations of the conditions: (1) That civil engineering periodicals do not publish usable facts, or (2) that most civil engineers have neither recognized the necessity of continuous study nor formed the habit of constantly searching for new information.

The first of these alternatives can be dismissed without argument, for nearly every recent civil engineering book is full of references to, and quotations from, articles that have appeared in civil engineering periodicals. Evidently the most studious of civil engineers—the authors of engineering treatises—find the contents of civil engineering periodicals worth while.

The other alternative therefore seems inescapable. Of course, it may be said that the non-readers among civil engineers are those who have never gone to engineering colleges. The writer's observation gives no support to such an assumption. Indeed he has usually found that the man who has been able to train himself to be a civil engineer without the aid of an engineering college is usually more of a student of engineering books and periodicals than is the graduate of such a college. His struggle to make an engineer of himself has developed in him not only facility in searching for knowledge, but has founded in him belief in the value of such searching. Finally, it has habituated him to be a searcher for knowledge.

On the other hand our present courses in engineering often tend to atrophy the instinct of exploration. The teacher does the exploring, and presents to the student the results in a form readily assimilated. During four of the most formative years of life, the engineering college student is not made to search for and analyze data.

The late Professor Henry Janes, in his "Talks to Teachers on Psychology," says that he believes most men form nearly all their habits before they are twenty-five years old. The writer believes this to be a fact. Granted that it is, how pitifully weak becomes the argument that engineering students need not be trained in searching for data because that is a training that they will naturally impose upon themselves after graduation.

The writer fears that in the desire to teach students the "principles" of science and engineering, a great error is being made by many teachers. Principles, it is true, should be taught. But without a great store of details in one's mind, or readily accessible, principles can not be put to the best use in practice. In fact a strong argument can be advanced in favor of the proposition that principles should be taught only after many details of practice have been learned. Cer-

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*Discussion at the April [illegible] above mentioned subject. An abstract of Mr. Burt's report appeared [illegible]

[illegible] the [illegible] been the men who have [illegible] and from the details have [illegible].

[illegible] for the teacher [illegible] to the student [illegible] to be [illegible] to hunt for [illegible] must be trained into him.

[illegible] almost a fetish in [illegible] it to so much [illegible] that expresses a [illegible] of facts. A knowledge of principles therefore greatly reduces the strain upon the memory and facilitates the operation of the mind. But known scientific principles are countless in number, and they are daily increasing by the hundreds. It is beyond the power of any human mind to memorize more than a small fraction of all the scientific principles now in print. True, some principles are of wide scope and others are narrow; but if the teaching of principles is to be the prime object, well [illegible] to be drawn.

More and more it grows upon the writer that the formation of habits to be pursued in after life should be the prime object of teachers. Students can certainly not be taught many details, nor in fact can they be taught many principles, rela[illegible] they can be taught how and where to search for information, how to classify and organize the knowledge thus acquired, and how to go about to apply the knowledge.

Mr. Burt puts it very well when he says that one of the purposes of training is, "To develop in the mind the powers of analysis, synthesis, obervations, imagination and logic, so that the man will always be a student." The writer is glad to see mention made of "logic." There are few engineering colleges that require the study of logic as a formal course. Unfortunately there is no very satisfactory text book on logic. Perhaps Bain's is the best one for class purposes. Some teachers prefer Jevons. But there is no doubt that the study of formal logic is very useful as a training in the use of words as tools for reasoning. Less can be said of existing books on logic as aids in inductive reasoning. No logic whatever discusses inventive or imaginative reasoning. Hence teachers of logic must themselves go beyond the covers of the text books on logic if they are to arouse deep interest in the truly fascinating science of systematic thinking.

The Architect as a Citizen

The following resolutions were adopted March 11 by the Illinois Chapter of the American Institute of Architects:

"Whereas, We recognize that the architectural profession is concerned, whether or not it is formally consulted, with everything that is done or left undone either by individuals or by our municipal, state, or national governments in building, housing, or town planning; and,

Whereas, It is our duty to our nation to have a distinctive professional opinion as to what needs to be done and to formulate a constructive criticism upon the acts of our public officials; and,

Whereas, It is a proper function of our profession to serve the state, therefore be it

Resolved, By the Illinois Chapter of the American Institute of Architecture in regular meeting assembled, That we tender to our municipal and state authorities our services in an advisory way; and be it further

Resolved, That we urge upon our members the utmost importance of each and every member of the Society taking more interest in the affairs of our municipal and state governments, and in performing their full duty to their state and city by performing their full duty as citizens."

Industrial Notes

[illegible], Inc., [illegible] has opened a New York office at 1505 Equitable Trust Bldg., which will be under the di[illegible].

The American Steam Conveyor Corporation, Chicago, announces [illegible] the National [illegible] its eastern territory with headquarters at the New York office, 110 West 40th St.

News Letter

St. Louis Items.

[illegible] A. Ware has been laid up at his home near [illegible] for the past month. Was hurt by an auto in Wellston, Mo. But from reports we expect him back on the job in a couple of weeks. [illegible] is taking care of the office in the Boatsman [illegible] during his absence.

[illegible] & McCarthy, Chicago, were awarded one of the best grading jobs let in this vicinity for some time when they secured contract for grading the grounds for the new $5,000,000 plant to be erected by the General Motors Co. on 105-acre tract at Natural Bridge road and Union avenue, St. Louis. P. Strang will be in charge [illegible].

John [illegible] is shipping a team outfit on Dunn & McCarthy's big job here.

[illegible] Riley of Clapp, Norstrum & Riley, Chicago, passed through here the other day on his way to Hot Springs.

[illegible] has his 18 teams and machine outfit idle at Arkansas City, Kas. He is in the market for any kind of grading.

John [illegible] Morganford road, St. Louis, Mo., wants to [illegible] on some job in this neighborhood.

Ira J. Printy has gone back to Arkansas to ship the balance of his team outfit on the levee and channel widening job in Columbus, Ohio.

[illegible] Bros. are on a bridge job at Columbus, Ohio.

[illegible] Bros. have their outfit at work on the Pennsylvania R. R. at Rayland, Ohio.

W. L. Carlile, 712 Western Indemnity Bldg., Dallas, Texas, wants some teams for railroad grade work near Ft. Smith.

J. E. [illegible] is finishing up a ditching job for the Katy R. R. near Walnut, Kan.

F. E. [illegible] has his outfit at work on a bank widening job on the Rock Island R. R. in Western Texas.

Our old friend Mason, of Mason & Hanger Co., put in an appearance here one day last week.

Contractors when in want of work or labor for their outfits write Koenig's Labor Agency, 612 Walnut street, St. Louis, Mo., or 503 Delaware street, Kansas City, Mo.

Louie Carlton after an absence of about 12 years from the city showed back here last week. Louie has quit contracting and branched out in the oil business at Wichita Falls, Texas.

Harrington Bros. were awarded a water pipe and sewer contract at Benton, Ill., by the United States Steel Co. They are in the market for any kind of grading suitable for a 30-team outfit. 3959 Flad avenue, St. Louis, Mo., will catch them.

Earl J. Fraser will be with the Dunn-McCarthy Co. on their new job here.

A. B. KOENIG

Personals

James A. Rogers has been elected superintendent of buildings of Manchester, N. H.

Edward Mahnke has been elected building commissioner of the city of Waterloo, Iowa.

Capt. John W. Wheeler, Crown Point, Ind., has been appointed bridge inspector for Lake County, Indiana.

Charles E. Grubb, formerly assistant county engineer under the late James Wilson, has been appointed county egineer.

John D. Clark, L. C. Phillips and G. A. Semrad have organized the Cheyenne Construction Co., Cheyenne, Wyo., and will engage in a general contracting business.

Maurice J. Sullivan, for the past 7 years city architect for Houston, Tex., has resigned position and has opened offices in Houston for general architectural work.

George S. Webster, director Department of Wharves, Docks and Ferries, of Philadelphia, has been appointed member of the division of engineering of the National Research Council, Washington.

The Aberthaw Construction Co., of Boston, Mass., has opened a Philadelphia office at Room 101 West End Trust Bldg., E. V. Schafer, formerly assistant mechanical engineer at the League Island Naval Air Craft Factory, is in charge.

Langthorn Co., Inc., has opened offices at 2 West 45th St., New York City, for the purpose of conducting a general engineering and contracting business. The officers of the company are Louis J. Snyder, president; J. L. Langthorn, vice president; E. B. Glatz, treasurer, and M. W. Byers, secretary.

Rudolph E. Lee, A. I. A., of Clemson College, S. C., T. A. MacEwan, of Pittsburgh, Pa., and A. R. Turnbull, of Charlotte, N. C., have opened offices at 1214 Realty Building, Charlotte, N. C., for the practice of architecture and engineering under the firm name of Lee, MacEwan and Turnbull. A. R. Turnbull is the general manager of the firm.

Daniel T. Pierce, formerly assistant to the president of the General Asphalt Co., who has just returned from more than a year's service in France, is located temporarily at Room 1031, 120 Broadway, New York. Mr. Pierce will represent important Franco-Italian interests as well as acting for American manufacturers seeking business in France and other European countries.

Obituaries

George O. Nagle, city manager of Wheeling, W. Va., died April 15, aged 48.

Thomas Moloney, formerly building inspector of Jackson, Mich., died April 2, aged 76.

Owen Brainard, member of the firm of Carrere & Hastings, architects, New York City, died April 2, aged 54. Mr. Brainard supervised the construction of many prominent buildings in the United States and Europe. He assisted in designing and supervising the structure of the New York Public Library, the Senate and House office buildings in Washington, and extension of the United States Capitol, the Yale Memorial Buildings and the Cornell University Building. He designed the New Theater in Manhattan and the Industrial Villages erected for the employes of the United States Steel Corporation in Pennsylvania.

John T. Dickerson, general manager of the Strauss Bascule Bridge Co., Chicago, died April 14, of pneumonia after an illness of a week's duration. Mr. Dickerson was 40 years of age and a graduate civil engineer of Rose Polytechnic Institute of Terre Haute, Ind., class of 1902. For the past 7 years he has been identified with the Strauss Bascule Bridge Co. Prior to 1912 he was assistant engineer and general sales engineer with the Scherzer Rolling Lift Bridge Co. of Chicago for a period of 5 or 6 years, and before that he was employed in the bridge departments of the C., B. & Q. and C., R. I. & P. R. R. companies and the American Bridge Co. at St. Louis, Mo.

Foreign Engineering Review Issue

ENGINEERING AND CONTRACTING

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Cleveland Office: Room 413 Engineers' Bldg., LEO EHLBERT, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The *articles* in the first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering and contracting field. The *articles* in the first and last issues of each month (1st and 4th Wednesdays) completely cover county engineering and highway engineering and contracting. The *articles* in the third and last issues of each month (3rd and 4th Wednesdays) completely cover steam and electric railway location, design and construction. See the "mast head" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation and Dredging
(b) Rivers and Canals
(c) Quarries and Pits
(d) Railways, Steam and Electric
(e) Management and Office System

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials

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Our Foreign Engineering Review Issue

Four months of the year have five Wednesdays and on each of these quarterly "5th Wednesdays," Engineering and Contracting is published as a large special issue. One of these special quarterly issues is devoted entirely to brief descriptions of new equipment in the civil engineering and contracting fields. This was published on Jan. 31 last. The other three issues are given up to civil engineering developments and improvements in foreign countries.

American engineers are justly proud of their own engineering achievements, but they should not let their national pride deter them from studying carefully the engineering works of other nations. Relatively few American civil engineers and contractors have access to foreign engineering periodicals. Hence our decision to publish these large special issues annually, giving comprehensive summaries of the most useful information to be found in foreign civil engineering periodicals and technical society transactions.

A British Point of View of Government Ownership

From Engineering, Dec. 13, 1918

The announcement made last week by Mr. Churchill that the Government had decided on the nationalization of the railways, renders it incumbent on engineers to exert such influence as they possess to prevent a repetition of the mistakes which have occurred on previous occasions when services hitherto administered by private companies have been taken over by the public. It unfortunately happens in the present instance that the possible advantages of nationalization lie on the surface, and are obvious to the meanest capacity, but it is all important for the future of the transport problem that this "meanest capacity" shall not have the determining voice in the establishment of the new order of affairs. The dangers to be feared as a result of the suggested action are less patent, and are less likely to be generally appreciated, having relation to mind rather than to matter.

Orators have been eloquent in depicting public companies as caring for dividends merely, and nothing for the public. Nevertheless, in actual practice it has been the post office, and not the railway officials, which by their neglect and indifference have continued to provide themes for the pen and pencil of our modern satirists. The supercilious young lady who is occasionally found behind the counter of our post offices, has had no counterpart in our railway services.

How is it that in this country every great service taken over by the public from private companies has failed to realize the anticipations of the advocates of the change? The telegraphs were purchased with assurances of the most prosperous and profitable future. But few years had elapsed, however, before it had to be admitted that these forecasts had been wholly falsified, and that the service was being run at a loss, although the companies, hampered by restrictions from which the nationalized undertaking was free, had been nevertheless worked at a profit. Much the same has happened with the telephones, and it has not been without interest to observe during the past few days in one column of a journal, violent complaints of the inefficiency of the nationalized telephone service, and in another column rosy anticipations of the economies and improvements to be effected by the nationalization of our railways. Still a third instance of how far realization has fallen short of anticipation is afforded by the Metropolitan Water Board.

The telephones, of course, were acquired at considerably below a fair valuation. No credit was given for the imponderables which often constitute so large a proportion of the value of a going concern. Mere materials were alone assessed, and no allowance made for the capital necessarily expended in pioneering work and in building up the organization. In America materialism is less rampant than here, and the Interstate Commerce Commission has definitely laid it down that expenditure, even on an experiment or enterprise which proved unsuccessful, may be fairly taken into [illegible] If comparison is to be made, [illegible] discounted on end of [illegible] grave failures, yet [illegible] a fair charge on the [illegible]

In the case of the Metropolitan Water Board, it has been frequently asserted that the price paid was excessive, but as a matter of fact, the value of the mains there was nearly equal to the full amount paid. To lay these mains in the open country would have cost, under the most favorable conditions, [illegible] and the cost of main laying in towns is, as is well known, at least three or four times as much. Hence, the value of the mains alone was nearly equivalent to the full purchase price. To repeat our question, how is it that in all these cases there has been such a wide discrepancy between promise and performance?

Fundamentally, the main reason lies in the difference in the organization. The administrative charges tend to be much higher under public than under private control. This is, no doubt, contrary to anticipation, and some would assert, contrary to reason. Reason, however, is of itself but an indifferent guide to truth, and the late Mr. W. B. Bryan, chief engineer to the board, has stated that the administrative cost of the London Water Board exceeded the aggregate administrative costs of the eight companies which it replaced. According to a recent statement by Mr. Harold Cox, a similar result has followed the nationalization of the Swiss railways. He said that the administrative staff is larger than that of the five companies which were absorbed. The real cause of the inefficiency of the public services seems to lie in the fact that these increased administrative charges are all due to an increase in the clerical and statistical staffs, and to a reduction in the departments responsible for creative thought.

An interesting light on this matter is shown by a study of the terms on which the staff of the telephone company was taken over in 1911. Here the rule was laid down that any company official who, by showing initiative and imagination in the company's service, had secured a salary of over 700 l. ($3,500) per annum, was, ipso facto (save in special cases), disqualified for the Government service. So far from "men of push and go" being required, it was to a large extent the men of "push" who had to "go."

In fact, the whole system of organization was changed. As described by a district superintendent a couple of years after the transfer, all initiative and independence of judgment was suppressed. He knew, he said, exactly where certain matters were going wrong, and how they could be remedied, but if he made any move whatever he would be straightway informed "that the matter did not concern his department." Again, small difficulties which, under the company's management, would be settled locally out of hand, had, under the new regime, to be referred to headquarters. The original memorandum received additions at each step of its stately progress from official to official up to the one man who alone had power to settle the affair, trivial though it might be. In many cases, moreover, the memorandum on reaching this official was returned along the same devious path for further data, and had again to retrace its steps to the departmental head before a final decision was taken. The net result was that instead of the one man who understood the whole of the local conditions settling the matter in half an hour, hosts of officials all had to spend time on it, and weeks might elapse before the final settlement. Obviously, any such system as this must necessarily find employment for a vast army of clerks so it is easy to see how the administrative costs are increased.

The evil of such a system does not end here, one of its consequences being that the head of the department, who ought to have ample leisure for the consideration of important matters of policy, has practically his whole time taken up with trivialities which, in any efficient organization, would have never reached him. In this connection, it may be noted that on certain of the great American railways, it has been the custom to relieve the vice-president of all routine work, so that he and his immediate staff may give the whole of their time to the consideration of new proposals for increasing the effectiveness of the service. In the public services there is nothing analogous to this, and, indeed, the powers even of the heads of departments are often extraordinarily, and indeed ludicrously, restricted.

The [illegible] traditional organization of our public services has been to discourage initiative and independent judgment on the part of subordinates, and greatly to restrict responsible action in the case of heads of departments. As one result, we have not in any public service "la carriere ouverte aux talents." Able young men, who later on should fill the higher administrative posts, get no opportunity as subordinates for the display of any but humdrum qualities, and are thus not sorted out from the general average. As one result, men competent to supervise the many new undertakings which had to be extemporized during the past 5 years, were found almost anywhere save in the civil service. Indeed, not the least debt of the nation to the railway companies is due to their work during the past years revealing the abilities of the numerous men which the state borrowed to control so many of our war services.

If the question of the nationalization of our railways is to come up for discussion, it is perhaps as well that it should come now, whilst the memory of this contrast between the results of company organization and public services organization is fresh in the public mind. It should make it easier to resist the attempt to establish a new organization molded on traditional lines, which all experience shows to have proved singularly unsatisfactory.

No doubt, the German state railways were managed with fair efficiency, even if the staff was mainly parasitic on English or American thought, but an organization which may be effective in an autocratic country is unsuited to a democratic one. Commenting on this point some 18 months ago, we observed that whilst the best public service in a democratic country had never, in the whole course of history been as good as the best in an autocratic country, yet, nevertheless, there was reason to believe that the worst in a democratic country had never been quite so bad as the worst in an autocracy. Whether this view can still be maintained depends very much on whether the Bolshevist regime in Russia is to be regarded as autocratic or democratic. Our own view is in favor of the first alternative, but some of the most fervent of those who claim to be the apostles of democracy in this country seem ardent advocates of the contrary opinion.

Amongst the advantages claimed for the nationalization of an industry is that the reserve of stores will be greatly reduced by the greater standardization which becomes possible. The theoretical benefit of such a change is obvious, but experience shows that it may, on occasion, be purchased somewhat dearly. In the case of the telegraphs, the extensive standardization of instruments effected on taking over these undertakings from the companies, destroyed competing centers of thought, and the result was to a large extent stagnation. A leading American authority has stated that up till 1870 more than one-half of the important improvements effected in telegraphy originated in Britain, but that subsequently the post office simply imported improvements ready made from abroad. On the other hand, we continued as before to make the most important contributions to improvements in submarine telegraphy, which remained under private direction and control. An instructive example of the difference between public and private action in this regard is afforded by the history of long-distance telephony. The principle now in use originated, as is well known, with Oliver Heaviside, but our postal authorities refused to help him to practicalize his ideas. Some abortive experiments were made, it is true, but not under his direction or control, and the scheme was reported to be a failure. Some years later, Mr. Heaviside's idea was taken up in America, and most ably worked out by Professor Pupin, who in contrast to Mr. Heaviside, received the most generous support and reward from the Western Union Telegraph Co., with the result that all difficulties were overcome, and the scheme made a practical success. Pupinized cables have, moreover, solved the difficulties of submarine telephony. It will be noted that there are many more systems of state telephones than company controlled systems, yet this great advance was secured by a company and not by a state service.

The sole chance of maintaining the efficiency of our railway services under state control would be that the essential features of the present organization should not be materially changed. Of course, the ill effects of a change would not be experienced at once any more than they were in the case of the Metropolitan Water Board. In fact, a few years after the transfer the chairman of that board made a grandiloquent speech in which he enumerated the many improvements which he claimed were due to the board, all these, he said, had been made "without one penny cost to the public." As a matter of fact, up to that date the board was, to all intents and purposes, living on accumulated capital. Every work, whether completed or commenced up to that date, was, in fact, a company scheme worked out before the drastic reduction in the engineering staff. Later on, when really new works had to be undertaken, the weak spot became evident. The staff was inadequate and the few creative minds retained were overloaded with routine.

With the transfer of the railways to the public, there will, undoubtedly, be a strong movement to reduce very largely the higher technical posts. Under mistaken ideas as to the all-importance of abolishing over-lapping, independent centers of thought may be suppressed, with the result that our railways may become purely parasitic for ideas on company-managed lines in other countries. It is of first importance that this tendency should be resisted, though, even if former precedents be followed, the evil effects would not appear at the outset, any more than they did in the case of the Metropolitan Water Board. The best of the old officials—or some of them—would, no doubt, be retained, but if all initiative in subordinates is to be discouraged in accordance with the past traditions of our national services, it will be impossible, as the present leading men die off or are superannuated, to replace them with men of equal caliber.

The Engineer and the War

From Engineering, Nov. 15, 1918

For the first time for nearly 4½ years we write free from the sense of everything being overshadowed by war and of being subservient to the single end of attaining victory. The moment for which we have all waited so long, and which we have sometimes thought was near, only to recognize that it had again been deferred to some distant date which we could not specify, occurred last Monday morning, when the High Command of the German Army accepted the rigorous terms of the armistice laid down by the Allies and the United States. These are so defined that there is no chance of the enemy refusing the conditions of the peace we shall dictate, and we are at liberty to take a rapid survey of what the engineer has done in attaining this great object.

The War Office has never realized the value of the mechanical engineer. In view of the smallness of our army he ought to have been given a free hand so that each man might have had his powers multiplied manifold by machinery, just as has been done in manufacture. But we were behind Germany in many, if not in all, respects. We were almost destitute of machine guns, we had no siege guns such as those which smashed the Liege forts and opened the road into France, we were deficient in aeroplanes, motor transport was unorganized, our airships were experimental, and we had no efficient means of defense against submarines. Now, on the eve of the Peace Conference, we are the equals of Germany in every respect, and her superior in most. We have machine guns and to spare; our heavy artillery answers every demand upon it, and if we are told we have no guns such as bombarded Paris from an unheard of range, we can reply, like the Roman, that our weapons are long enough to reach the heart of our enemy and have done so. In aeroplanes we are preeminent, and have cleared the sky again and again. In speed, in maneuvring ability, in weight-carrying capacity the machines designed and constructed by British manufacturers can bear comparison with any, and in the hands of British pilots they have often secured victory over odds that were most disproportionate. The output of motor transport has been a triumph of the manufacturing engineers of this country.

Possibly the greatest of the engineer's contributions towards winning the war was the tank. It was entirely a new military engine, and at its appearance it spread dismay among the enemy. It broke down the most difficult obstacle to a charge —the barbed wire fence—and it routed out machine-gun nests which were proof against direct attack by infantry and difficult to reach by artillery. The tanks have saved tens of thousands of British lives, and alike in the conception, design and the secrecy of their construction have reflected credit on everyone concerned, and especially on those connected with the Admiralty, who were the moving spirits in the enterprise.

At the commencement of the war we were as well, if not better, provided with submarines than our enemies, but we had very little scope for their use. Our boats could sail the seas with safety, but penetration into the harbors where our foes lay behind booms and minefields was almost impossible. It was very seldom that a German ship was to be found around our coasts, and then it was generally disguised very effectively. The Germans, on the other hand, could find a target every day, and a great many of their torpedoes got home with fatal effect not only on merchant ships, but also on war vessels. For a time we were almost helpless against this method of attack, and the engineer had a most difficult task set to him. Step by step, our means of defense grew more efficient. We fenced off whole areas of the Channel with nets such as had never been seen or imagined before. We mined in a systematic manner hundreds of square miles of the North Sea; we evolved the motor boat with its single gun, and the skimmer with its single torpedo; we had our decoys and our mystery boats, while overhead the crews of our airships strained their eyes to trace the shadows of the submarines as they glided below the waters of the Channel. Depth bombs were devised and have accounted for dozens of U-boats. Listening devices have been perfected until they will pick out the beat of a submarine propeller at a distance measured in miles. So successful have been the efforts of the engineer that lately nothing but the iron discipline of the German Navy could force the half mutinous crews of the submarine to run the gauntlet of the numerous perils that awaited them.

We have no space this week to discuss what is going to be the position which the engineer will occupy in the future. He has found an antidote for every carefully prepared appliance of the enemy, and has armed 5,000,000 men with the most exact and efficient weapons ever seen. Even the daily press talks of the late struggle as an engineer's war. Will engineers, in their corporate capacity, be content to be summarily dismissed when the Government has no further need of them, or will they, like the medical men, insist that they constitute an honorable profession which demands terms of recognition and treatment consonant with its usefulness and its dignity? As long as the war lasted patriotism prevented any action which suggested self-seeking in the slightest degree, but when peace is concluded there can be no reason why engineers should not claim and secure the position they have demonstrated to belong to them.

Salaries of Assistant Surveyors in Ireland

From The Surveyor, Nov. 22, 1918.

If further proof were needed of the extraordinary view taken by certain members of county councils in Ireland with regard to the value of the services of the assistant surveyors to those bodies, it is afforded by a discussion which took place at a recent meeting of the Neath County Council. At present these officials receive salaries ranging from £100 to £120 a year with war bonuses of a little over £30 in addition, and it appears that they have had the temerity to ask for an increase, a request which the Finance Committee recommended the council to refuse. One member for the council moved that the report of the committee be referred back for further consideration, and in doing so referred to the assistant surveyors as professional men; whereupon a Mr. P. J. Kennedy rose and in the course of a speech against the motion cast doubt upon the accuracy of this description, and proceeded to say that an assistant surveyor was "a kind of overseer," and was in the position of "a steward to the county council." The use of such expressions reveals a total incapacity to appreciate either the nature of a surveyor's work or the qualifications that are required for its proper discharge. As the county council rejected the motion for a reference back by a large majority, we can only assume that they were in agreement with Mr. Kennedy's views. We suggest for their consideration that next time an appointment is to be made they should advertise for "a kind of overseer" and not for an assistant surveyor. If the former is not what they really want, it is at least what they deserve.

The Pecuniary Rewards of Technical Engineers

[illegible]

[illegible] that the head of one [illegible] expressed himself as by [illegible] then active [illegible] technical schools of [illegible] the number grad-uating annually might be small, the supply of scientifically [illegible] was well in excess of the [illegible] in this country, of the heavy electrical industries been permitted by Parliament [illegible] the prospects of the technical graduate of that day might have been most materially improved. Instead of relying on other nations to do the thinking for us, we should have found openings and opportunities for many able young men of our own, to the very great [illegible]. Today as in 1890, there is [illegible] facilities for technical education, and it remains to be seen whether the public has learned anything whatever by the experience it has gained during the past quarter of a century, and whether it will, to its own great advantage, see that our economic conditions and policies are such as to foster a demand for the proposed enormous increase in the annual output of scientifically-trained engineers, chemists and biologists.

Unless past practices and precedents are very substantially [illegible] the majority of the students from the enlarged technical schools will find it necessary to seek a career in [illegible] than that of our manufacturing industries. It may, moreover, be taken as certain that we shall not succeed in [illegible] our enormous war debt without making the fullest possible use of such creative brains as the nation may be fortunate enough to include amongst its population. Admittedly geniuses are rare, nor will genius readily develop in inappropriate surroundings. To secure the development of one great artist requires the backing of a society in which art is pursued by many who are not great artists. Shakespeare stood supreme amidst a crowd of lesser literary lights, and George Stephenson grew up in a Northern mining area where clever mechanics were common. To insure that the men of exceptional talent who will be required for the re-creation of the wealth destroyed during the past 4 years, shall be forthcoming, prospects of a reasonably successful career must be open to men of less striking abilities, who will in fact be required to attend to the indispensable, though it may be uninspiring, common round and daily task.

How in the past have the prospects of the average young engineer compared with those of his peers in other professions? Some interesting data on this head were given by Mr. [illegible] Price Abell in his recent address to the Derby Society of Engineers.

He stated that the education of a doctor extended over 5 or six years and cost about £1,000 (about $5,000). After completing the course 99 per cent of the medical graduates have been, Mr. Abell says, certain of employment at incomes beginning at £200 a year and rising to an average of £500 per annum at the age of 30. One medical man in a thousand makes an income of the order of £5,000 a year. The clergyman's education costs, Mr. Price Abell stated, some £300 to £800, and on completion employment was certain at an income ranging from £150 at the outset to an average of £220 a year at the age of 35. There are about 40 prizes open to clergymen bringing in incomes of £5,000 to £15,000 a year. A solicitor's training, Mr. Price Abell continued, costs from £300 to £800 to procure, and there is a 99 per cent chance of subsequent employment at rates running from £100 to £200 per annum in the earlier years, with an average income when beyond 30 of £300 per annum. The large prizes are more numerous than in the medical profession.

In the case of the engineer, Mr. Price Abell said that, taking both premium and non-premium pupils together, the chances for an engineer (not including of course mere craftsmen) are represented by the following table:

	Per annum.
[illegible]	£1,000
[illegible]	500
4.5 per cent will make over	300
3 per cent (serving abroad) will make over	300
37 per cent will make over	200
37 per cent will make less than	200

Further, as matters stood before the war, every advertisement of an engineering post having attached to it an income of £200 to £300 per year, brought in over 200 applications. If, as is proposed, the output of qualified engineers is to be greatly increased, then unless conditions are very materially altered no positions will be available for the majority, and salaries for highly qualified men will be liable to fall to a limit with which even the Treasury, with its ingrained contempt for "stinks" and every kindred pursuit, might express itself satisfied.

Experience during the past 4 years has very conclusively demonstrated that the accountant's so-called "non-productive" expenditure may, with great profit, be greatly increased. That our women folk have made every variety of munition, from complicated machine guns up to 9.2-in. shells, has been possible only because much more thought than ever before in the history of British industry has been expended on the study of industrial processes. In principle, if not in details, the Taylor conception of scientific management has been widely adopted. Technical staffs have been increased far beyond the proportions common in pre-war days, and this has rendered it possible to determine and instruct the operative in the most effective methods of work. Much thought has been expended in subdividing up complicated processes into a few simple elements, and each of these elementary processes could, it was found, be rapidly mastered by wholly unskilled labor. Some entirely new methods and tools have also been developed and have contributed their quota to the astonishing output of our shops during the past critical years.

For this extraordinary industrial development the aid of the skilled engineer has been a first essential. The demand for his services has been such that engineering has become for the time being perhaps the best paid of all the professions, at least so far as the average man is concerned. Many of our leaders have, of course, made great personal sacrifices—giving their invaluable services either gratuitously or at much below the market value.

Wealth has been defined as consisting of exchangeable values. At the present moment the exchangeable value of the intensified output of our factories is high in a certain limited though strictly temporary market. When this market fails, are these great engineering shops and steel works to be closed down, or is the nation prepared to consider without prejudice, or parti pris, whether by an appropriate economic policy it may not prove feasible to keep these great workshops nearly as active in the arts of peace as they have been in those pertaining to war?

A wise decision will need the consideration of all the factors involved in the question, and not merely of those immediately obvious, such as are commonly alone considered by the materialistic school which has been predominant in the past.

Censoring Technical Journals in America

From The Surveyor, Feb. 28, 1919.

Censors, as we know in this country from long and painful experience, have notions with respect to publicity that are peculiarly their own; but it has been reserved for the Post Office Department of the United States to prove that ingenuity has practically no limits when it is cultivated as a frame of mind and a guide of conduct by these officials. The Municipal Journal of New York, in its issue of Feb. 8th, makes the announcement that the Post Office Department, by the new postage rate law, is required to classify all the matter that appears in periodicals as either advertising or not advertising. In making this classification it has decided that the naming of the manufacturer of, or dealer in an article is advertising. Thus, if in an editorial describing concrete paving the Journal should state that the cement used was furnished by the Beta Cement Company, or that the expansion joint material was made by the Turrett Company (real names are not, of course, given, because, as is pointed out, the editorial from which we quote would probably be classed as advertising matter), that makes the description advertising. The Municipal Journal remarks that engineers and contractors quite naturally desire to know what kinds of materials and equipment are used on different pieces of work, and proceeds to announce that it "will be glad to furnish this information by letter to anyone who will write asking for it." In other words, the newspaper qua newspaper sinks its identity, and practically disappears as regards certain specific forms of utility, and the editorial department is converted into a bureau of information run as a letter-writing agency. It may be, of course, that the censor's department, which can always be relied upon to sound a lower depth in eccentric mentality than any other department of the public service, has been placing its own construction upon the law of the State. If so, that is a matter over which our American contemporaries will be quite able to take care of themselves. But the fact that this interpretation is being enforced for the time being is certainly a striking testimony to the powers of the Post Office Department.

The Imponderables

From Engineering, Dec. 6, 1918.

Long years ago, when in the hey-day of his business career, Mr. Andrew Carnegie is reported to have observed that he could better afford to face the destruction of his vast works than the ruin of his organization, the efficiency of which had been secured only by careful selection and elimination extended over a long course of years. The works and their equipment could be replaced far more easily than the staff. The imponderables in fact outweighed in value the material. It is the same fundamental truth that Mr. A. A. C. Swinton had in mind when, in his recent presidential address to the Society of Arts, he insisted that the greater part of the capital of the civilized world is indestructible, since it consists not in mere structures and tools, but in the "know how" which civilization has inherited from the original thinkers of many past generations. Probably Mr. Swinton is correct in holding that little useful knowledge has ever been lost. Rome was overrun by barbarians, but her knowledge of the arts, to which we owe many of the amenities of civilized life, persisted. This knowledge, with the prodigious additions since made to it, was no doubt painfully acquired. Many a blind alley was fruitlessly explored before the true line of advance was detected; but the work once done remains done, and as a consequence we shall be able to replace the material losses of the war at the cost of much less effort than was expended in producing the originals. It is curious and noteworthy that it is the exponents of pure and applied science who are so insistent on the importance of the non-material. Our modern self-styled idealists, who degrade an hitherto honorable title, commonly speak and act as if economics were unadulterated materialism.

To a certain extent, of course, we are all to-day advocates of science and of scientific method. The value of science has been too conclusively demonstrated to be ignored, and as Mr. Swinton observed, even the Labor Party joins in the chorus which is acclaiming its importance. We are, however, inclined to question whether Mr. Swinton was correct in holding that the gibe with which Lavoisier was sent to the scaffold could not be repeated to-day. In fact, the Bolshevists, unless they are greatly maligned, would rejoice at the opportunity of massacreing many of our leading engineers and physicists. Moreover, it is greatly to be feared that much of the tribute to science now in fashion is merely lip service. The gulf between the methods of the engineer and scientific man and those of the popular politician is too wide for there to be much mutual sympathy, and it would appear from an address made some time back by the eminent American bridge builder, Dr. Waddell, that matters are little, if any, better in the States than here. The engineer wants to know how things actually do work in practice. If, for example, a proposal is made to nationalize an industry, he is unmoved by even the most eloquent forecasts as to the advantages to be gained, but asks how have similar predictions of prosperity been fulfilled in the past. Have, for example, the actual financial results of the nationalization of the telegraphs borne out the prophecies of 50 years ago, and have prediction and realization accorded any better in other equivalent cases? Another question by which the sincerity of the conversion of politicians to a belief in the methods of science may be tested is their attitude towards the manufacture of arms by private firms. Any fluent speaker can, with a minimum of mental effort, build up a most eloquent argument against the existence of armament firms. If, however, instead of trusting to his imagination, he would apply the methods of science and find out what actually has happened in the past, he would soon recognize that eloquence in such a case is wasted effort. For many months 70 per cent of the shell bodies used by the British in France were obtained from America, and France would have certainly been overrun had American law forbidden American firms to make munitions when their country was at peace. Such an example illustrates once again the futility of the belief that the human mind can arrive at workable truths by mere intuition or logic unchecked by obesrvation or experience.

In spite of the favor with which science is now regarded in political circles, he would be a sanguine man who expected that any Parliamentary party will easily discard its traditional usages, in favor of the scientific method. Nevertheless, we do most profoundly believe that whatever the difficulty of persuading our prospective governing classes to abandon the methods of Plato for those of Bacon, the future of civilization depends on the realization of this fundamental change. In the matter of bridge design, that eminent French engineer, M. Rabut, has formulated the maxim that when it is possible to measure, we should never be content with a computation, no matter how plausible the assumptions on which it is based. A corresponding maxim might well be applied to the work of rebuilding and reconstruction with which the nation is now faced. That there is nothing new under the sun may be a trite saying, but it is nevertheless substantially true, and a parallel in past history can probably be found for most of the schemes for social and economic reforms that are now being advanced. The history of such parallels will afford far better guidance as to the ultimate outcome of such schemes than the most logical deductions from the most plausible of hypotheses. The world war has afforded some striking instances of how history repeats itself even under apparently greatly altered conditions.

A first step towards the introduction of the methods of science into policy should be the broadening of the basis of education. The past specialization in classics must be abandoned, but care must be taken that it is not replaced by an equally deplorable specialization in scientific studies. In this matter we should be inclined to go further than Mr. Swinton, who suggests that we might have both great classics and great poets without the smaller fry. It is perhaps doubtful whether this view is correct. Great men in every department of human activity are seldom isolated pinnacles, but emerge like Mount Everest from amidst a vast mass of lower eminences. On one point, however, we most cordially agree with Mr. Swinton, and that is that of recent years far too much importance has been attached to laboratory work.

Mr. Swinton laid emphasis on the increasing intricacy and elaboration of the technical side of our industries. Undoubtedly the proportion of total expenditure devoted to what the accountant calls non-productive ends will have to be very greatly increased, but our recent experiences have shown us how profitable such expenditure may be. Methods of executing work have, during the past 4 years, received much more study than ever before, and as one result women have been enabled to turn out every variety of ammunition from 3-in. and 9.2-in shells up to machine guns and fairly heavy ordnance. Outputs have, moreover, been attained which in pre-war times would have been considered incredible. Woolwich, of course, did little. The type of organization usual, and perhaps unavoidable in the public services, is not such as to encourage originality, and indeed none of the private firms who were accustomed to make shells before the war have equalled the output of 9.2-in. shells reached in a certain south country works in which a shell had never even been seen before the war. Yet this shop, using female labor exclusively, but of course under highly capable male direction, easily surpassed every previous record in the production of this variety of munition.

For many years past there has been a section of the community which seemed to consider that to make a profit was a misdemeanor and to make a large profit was a crime. How efficiency is to be maintained and new industries built up without exceptional men reaping exceptional rewards is a problem to which the school in question has never attempted an answer. Mr. Swinton points out that no industry is in a healthy condition, or in a position to advance and increase, unless it makes good profits. The 20,000,000 tons of shipping which, together with the extraordinary development of the American steel industry, enabled us to beat the Hun, had both their origin in large profits, which were plowed back into the business because the business was profitable. Otherwise, any savings made would have been invested elsewhere. Further, no firm which it not making large profits is prepared to spend money on experimental work. The drawn wire filament [illegible] has [illegible] more than ever the poor [illegible] the large profits made by [illegible] A firm struggling to pay [illegible] the long series of investigations [illegible] the solution of this problem [illegible] closely connected, but still more [illegible] should remain under individual [illegible] We have had co-operative [illegible] for many decades, yet not [illegible] to our capacity to control [illegible] of wealth. Whilst individuals have [illegible] the pneumatic tire and wireless telegraphy, the co-operative societies have been content to [illegible] the thought and enterprise of [illegible] a single great industry [illegible] of their existence.

Payment of Labor by Results

[illegible] Jan. [illegible] 1919.

The Watt anniversary lecture of the Philosophical Society of Greenock, the native town of James Watt, was instituted [illegible] that on the great [illegible]'s natal day there should be an oration dealing with some phase of steam engineering. [illegible] imposed upon the lecturer has become one of great difficulty in successive years, as the whole field of choice of a topic has been covered so adequately by those who have [illegible] before. Thus in recent years there has been a tendency to direct attention to the economic rather than the purely scientific or technical phase of steam engineering. In other words, the man operating the machine rather than the machine itself has become the main theme, and this year the Watt lecturer, Sir William Rowan Thomson, K. B. E., dealt with some aspects of the labor remuneration problem in the future.

This problem is one which is asserting itself almost every day in connection with industry, and the solution will more readily be found if employers and employed are made fully cognizant of the bonus systems advocated and of their efficacy. As Sir William Rowan Thomson pointed out higher earnings, reduced hours of labor, greater output and reduced labor costs are the demands of the present day industrial situation. It is fully recognized by all economists that these desiderata cannot be achieved by remunerating labor on the time-rate system. The result of that system is, as pointed out by the lecturer, that a man was always tempted to do just as much as would prevent him from being discharged. There is not only a total lack of incentive on the part of the better class of workmen, but slackening on the part of the management. The introduction of piece rates of pay, while it stimulates workmen, has not the same effect necessarily upon the management. The bonus system—where part of the saving goes to reward management—does, on the other hand, produce the effect of stimulating the employer as well as the worker; and every effort put forth by the management is, of necessity, advantageous to the worker, as the week's earnings are increased without augmenting fatigue.

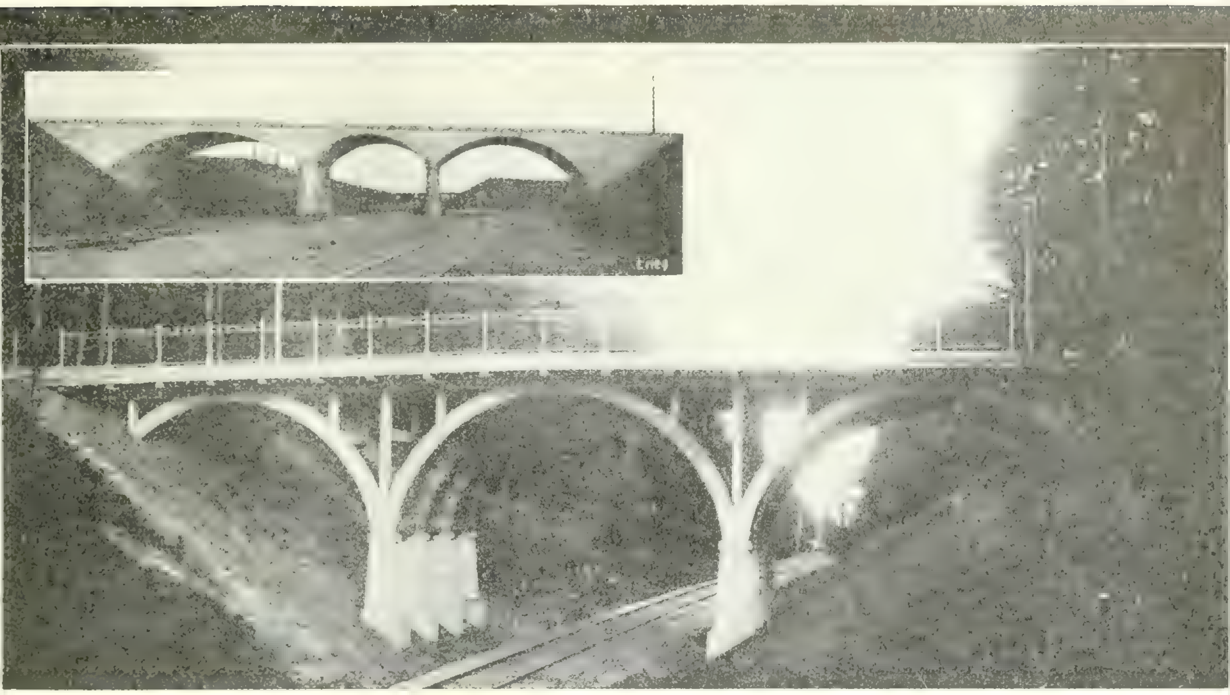
Sir William Rowan Thomson explained both the Halsey or Weir system as well as the Rowan system, contending in favor of the latter. Both systems are good, and the remuneration is equal in the case where 50 per cent of the time fixed for any job is saved. Beyond this the Rowan system gives a decreased rate to the worker, and for this reason there is less penalty to the employer or industry by any large error in time-fixing. The success of the bonus system is very largely dependent upon the ingenuity, foresight and general efficiency of the management. The lecturer said that any system of payment by results, to be effective and successful, must: (1) operate so as to increase the rate of output, not only without increasing the labor cost, but by actually reducing it; (2) make the reward of the workmen for his share in increasing the rate of output in accordance and commensurate with his exertions in producing such increase; and (3) be capable of quick, easy and safe introduction, and smooth and easy adjustment. He contended that if all the time-workers of this country had been put on payment by results at the beginning of the war, and had saved only one-third of the usual time taken, we should have been able to turn out the same amount of work with two-thirds of the men, or, alternatively, we should have done a larger amount with the same number of men, while the wages earned would [illegible] under the Rowan system and one-fourth under the Halsey or Weir system. Increased output was a combination of two factors: on the part of the workmen—augmented industry, great dexterity, thoughtfulness, foresight and the wisdom arising from experience, stimulated by an adequate, direct and immediate reward; on the part of the employer—better facilities, tools, power, light, materials and organization.

Engineers and Demobilization

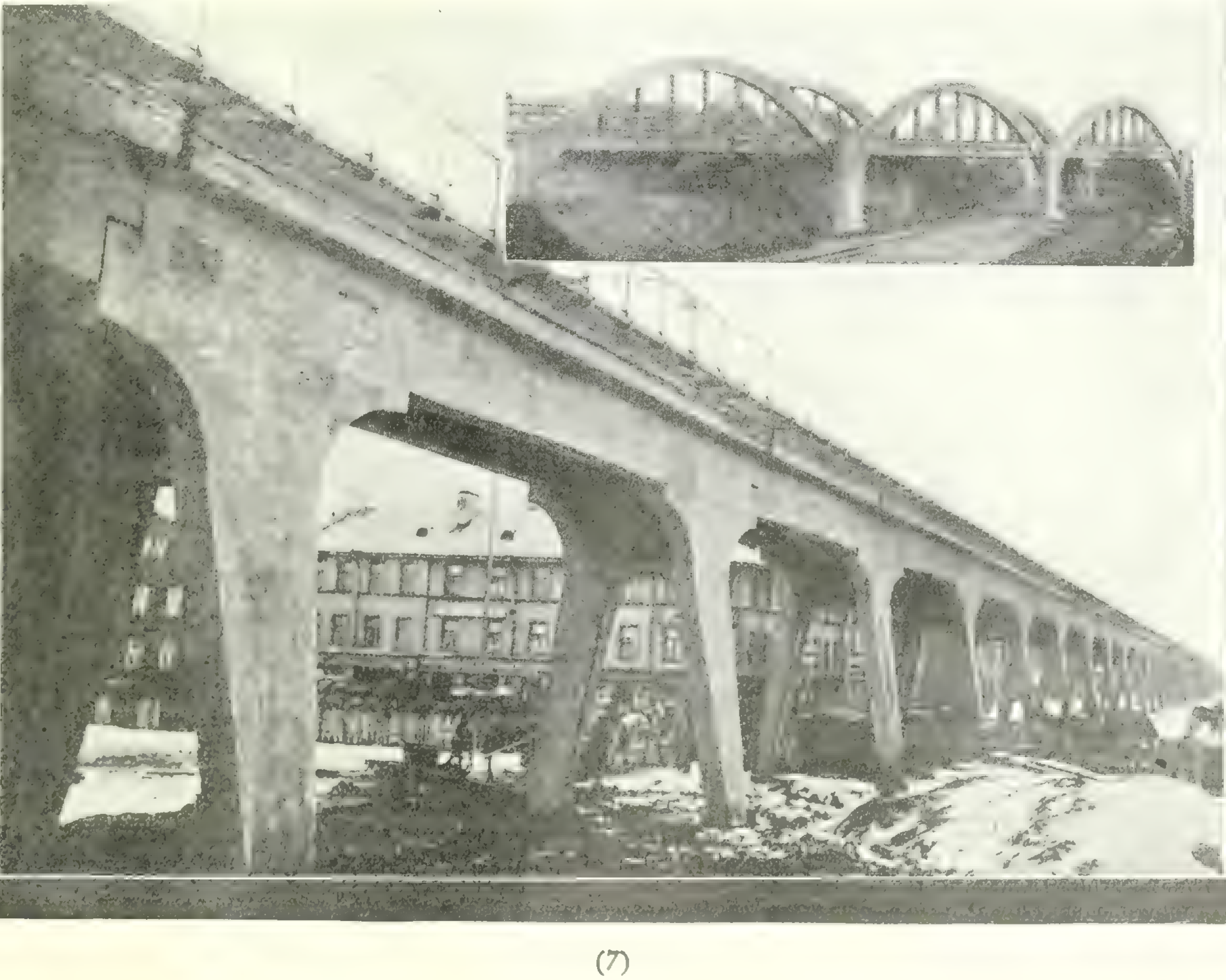
From The Surveyor, Feb. 14, 1919.

The importance of finding suitable work for engineers now leaving the Government service is only to be equalled by the importance of finding suitable men to do the pressing work which lies before us in the immediate future. Without doubt, there is so much work to be done that some of it will hang fire for want of competent men to do it; but on the other hand it is equally certain that unless serious steps are taken to bring employers and employed into communication many excellent men will find great difficulty in obtaining work. It is true that there is an employment bureau in connection with most of the engineering institutions and societies, but the work done is as a rule very mechanical and unsympathetic, and consequently the results are comparatively small. The young engineer, and especially the young engineer leaving the army, is in need of advice and sympathy; he is generally a capable man having good experience, but is often unable to find work, and very often ends by having to take up work for which he has no training or experience. It ought to be possible to establish an organization among engineers that would deal with such cases and would establish for itself the character for producing good assistants for the employer and a good employer for the assistant. It may be argued that this can only be done by personal knowledge and influence. This is quite true; but such knowledge should be obtained and such influence should be used for the benefit of the younger members of the profession. It is merely a matter of taking a little trouble and of finding the right man for the right job. It is of little use for the secretary of an employment bureau to obtain a list of names with details of the training and experience that each man has had, and to hand this to the firm or person requiring an assistant. After all, the engineering profession consists of human beings, and though boards and councils may be lacking in soul, the individual members are very human. Thus, some knowledge of the employer and also of the employed, is essential to the person who wishes to bring the two into touch satisfactorily. The work cannot be treated mechanically, or dealt with as a side issue. It requires special thought, care and initiative, and if properly handled, the chief drawback to engineers at the beginning of their career would be removed. Most of us can remember a time when we were faced with the difficulty of obtaining employment, a difficulty which had nothing to do with lack of merit, but solely with a lack of knowledge of the ways of the world and the places where one's legitimate work was to be obtained. All should be ready to help those who have given some of the best years of their lives to the service of their country, who have taken an active part in winning the war, and to whom the country owes the deepest debt of gratitude. Many of these men are looking anxiously to the future. They are men of experience, men who have been carefully trained, and such as are needed for the work which lies immediately before us. Cannot our leading societies and institutions take the matter up with more vigor, or cannot some central body be formed which will see that the right men are put into the right places?

Simplification of Earth Pressure Calculations.—Writing in Zeitschrift für Architectur und Ingenieurwesen (Part 5, 1918), Dr. O. Franzius, of Hanover, observes that in the case of designs for quay walls and embankment walls—in fact, for retaining walls of all classes—the earth pressure is usually obtained by geometrical construction instead of by the use of a simple formula. He states that the same engineer who is content to assume the safe load on the subsoil below the foundations at 5 tons per square meter and the safe load on a pile as 5 tons will calculate the earth pressure on the back of the wall most carefully by mathematical formulas, oblivious of the fact that the properties of the strata causing the pressure are as much unknown as those of the foundations.



The accompanying illustrations, reproduced from Concrete and Constructional Engineering, show four types of continental reinforced concrete bridges. The top view illustrates a viaduct at Odense, Denmark. This is of the arched slab form with earth filling. The large cut shows a bridge over the railway at Vejle, Denmark. It consists of a series of four piers on either side, connected by arched concrete ribs on either side, while similar ribs on the outer side are connected to a continuous abutment beam. The bow string arch skew bridge spans the railway at Odense, Denmark. The viaduct, shown in the lower view, was built for the Imperial Russian State Railways and has a length of 2,000 ft. Owing to subsoil conditions and the loads to be carried, piles were driven to a depth of 60 ft. below ground surface, and on the caps of these piles reinforced concrete supports were formed in pairs, thus forming a series of bridges with spaces between them.



Great English Invention for Sweeping Up Moored Mines

By HALBERT P. GILLETTE
[illegible]

[illegible] should be credited with [illegible] the [illegible] during the war, namely the "tank" and the "paravane" or ocean kite for sweeping up anchored mines. Each of these two inventions was suggested by certain preexisting American inventions.

The "tank" or land battleship was suggested by the American "caterpillar" tractor engine, a machine that lays its own track and picks the track up continuously.

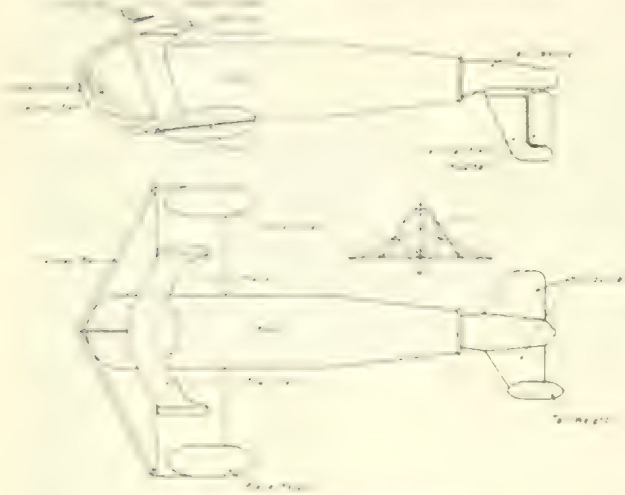


Fig. 1—Typical Paravane.

The "paravane" was suggested by the American "rudder boom" for deflecting floating logs or shingle bolts. This device is extensively used by western shingle mills. I described it originally in Engineering News about 16 years ago; and again in Engineering and Contracting of Jan. 10, 1917. In those articles I also described my own use of the same principles in designing a "river kite" by which a fishing net could be held out in a river so as to divert fish into a trap or into a "fish wheel" at the river bank. More recently (Engineering and Contracting, Sept. 25, 1918), I described a swinging pontoon bridge in which the river kite principle is used.

The "paravane" is an ocean kite towed by a ship. The tow line catches any anchored mines, and they slide along the towline away from the ship to the "paravane," as shown in Fig. 2. The "paravane" is shown in detail in Fig. 1, from which it will be seen that it is provided with a rudder. When the rudder is set at an angle with the axis of the "paravane," and a towline is fastened to the bow of the ship and to the "paravane," the latter flies away horizontally from the ship very much as an air kite flies up vertically from the land. An air kite is carried up by the force of the wind; a river kite is carried out into the river by the force of the current; and an ocean kite, or "paravane," is carried away from a moving ship by its impact against the water through which it is being towed.

"The Engineer," of London, in its issue of March 7, 1919, gives a detailed description of this interesting and important invention, an invention that revolutionized previous methods of sweeping up moored mines. The following is a reprint of that description.

Immediately war broke out a large number of steam trawlers was mobilized, fitted with 3-pounder or 6-pounder quick firing guns, and the necessary mine-sweeping gear. This gear consisted merely of a stout wire towed between two trawlers and kept at a settled depth below the surface, mainly by dint of the sweeping ships maintaining a certain distance apart. The sweepers working in pairs in echelon formation thus covered a wide channel, but the work was necessarily very slow and dangerous in that the sweepers themselves were unprotected. Both the French and Italian Governments evolved variations of this sweeping device, the wire by means of which the mine-mooring wire was caught and the mines dragged to the surface, being kept in [illegible] by means of [illegible].

But the problem of adequately sweeping large areas was not solved by these laborious methods. What was needed was a more convenient form of protection for individual vessels and a method of mine sweeping that would admit of high speed craft being employed, so that they could operate in conjunction with big ships steaming at high speeds. A great deal of original experimental work on this problem was carried out at Scapa Flow under Rear Admirals A. L. Duff, A. C. Leveson and E. F. Gaunt during the early part of the war, but the first proposals for gear of a new type emanated from Commander C. V. Usborne of the Colussus. His scheme was elaborated by Lieutenant Dennis Burney and materialized into the widely adopted paravane equipments which were found of enormous value during the last 2 years. The Burney scheme did not prove immediately successful, and elaborate experiments with it were conducted first at Portsmouth, where Admiral Sir Hedworth Meux contributed largely to its development, and afterward at Scapa Flow where the value of the device was finally proved during the years 1915 and 1916. In spite of the early difficulty in manipulation, which caused a good deal of skeptical comment as to the utility of the invention, the objections were overcome and the fitting has since become universal for all types of warships and merchant vessels.

The paravane itself consists of a torpedo shaped steel body to provide the necessary buoyancy, to which, on the side remote from the ship, and lying vertically in the water when the paravane is in its correct position, is a steel plate set at a small angle outwards from the center line of the paravane, which is parallel to the center line of the vessel; this plate, acting after the manner of an aeroplane wing, maintains the body at the required distance from the ship. The paravanes are towed in pairs, one on each side from the forefoot of the vessel in the case of their being used for purposes of protection, or from the stern of small craft if used merely as a sweep. The towing wire is attached to a frame connecting the plate to the body, on which is mounted a heavy cutter bracket containing a serrated knife blade by means of which the mine mooring wire is severed, the cutter being between the end of the towing wire and the frame. Internal mechanism, varying in design, and depending on the type of paravane, is fitted to regulate automatically the depth of the paravane below the surface of the water by means of a horizontal rudder. Fig. 1 shows the outline arrangement of a typical paravane, and Fig. 2 the general arrangement of the installation for the protection of mercantile vessels. It will be observed that the upper view in Fig. 1 is a plan; that is to say, that in use the float is approximately above the plane weight.

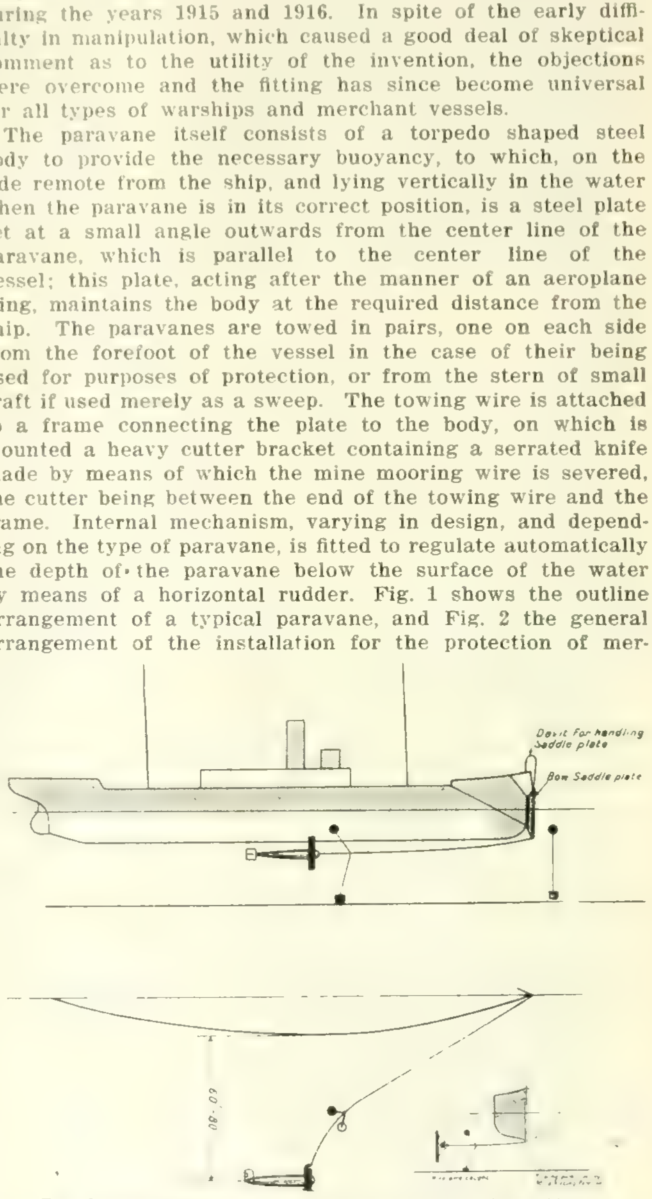


Fig. 2—Arrangement of Paravanes on a Merchant Ship.

The diversity of types of vessels and particularly the wide range in speed and intended nature of service involved considerable divergences in practice in the towing arrangements, as well as in the paravanes themselves. From Fig. 2 it will be seen that the point of attachment of the towing wire to the ship is as low as possible, and as far forward as possible, in order to obviate the possibility of any unprotected surface being presented. The paravanes themselves are set to run at a few feet beneath the level of the keel, in order to increase the protection, particularly if the vessel is trimming by the stern. To enable the towing point to be arranged in the essential position, warships and several large liners were generally fitted with a special attachment built on the forefoot, while mercantile vessels were fitted with a saddle plate which could be raised and lowered at will, or with a boom attachment which served the same purpose. It will readily be understood that the variations of form and general arrangement of vessel necessitated almost every vessel being considered on its own merits as regards the method of attachment. The lack of merchant ship docking accommodation for large warships seriously interfered with their rapid preparation for defense against mines.

Again, the variation in speed of ship involved differences in the design of paravane itself, and by degrees the position settled down to a closely defined condition embracing various types of protection and mine sweeping. Thus we had—

(1) Protector Type Paravanes.
  (a) Battleship type.
  (b) Battle-cruiser and fast liner type.
  (c) Mercantile vessels, "M" type.
(2) Mine Sweeping Paravanes.
  (a) The high speed type, as adopted for fast cruisers, was also used for sweeping by destroyers, being towed from the after end of the vessel.

Taking these installations in the foregoing order, except in detail, there is little difference, except in size. The "M" type differs mainly from either in the depth controlling apparatus. It is not proposed to describe this mechanism in detail, though it is obvious that the basis of all hydrostatic control gears must lie in the principle of the head of water actuating a flexible valve, which responds to the pressure head, with or without a swinging weight acting in conjunction with it. Many, many years ago this formed the "secret" of the Whitehead torpedo, and it was not until it was in universal international naval use that the futility of regarding it as really confidential became apparent. Even slight fluctuations of depth are sufficient to actuate the rudder and steady the movement of the paravane.

The cutter lies between the point of attachment of the towing wire and the towing frame of the paravane. The bracket holding the serrated blades is a forging of extremely tensile steel, as through it the whole pull on the wire has to be transmitted.

The Channel Tunnel

From The Engineer, April 4, 1919.

Although no definite decision has been reached to construct the Channel Tunnel, it is considered extremely probable that the scheme, which was first proposed over a century ago, will be sanctioned by the Government, and the work put in hand at a comparatively early date. Sir Francis Fox on March 31st delivered an address before the members of the Channel Tunnel House of Commons Committee on the proposed method of construction. He intimated that a procedure similar to that followed in the case of the Mersey Tunnel would be adopted, shafts being sunk at either end and twin tunnels driven on a slightly rising gradient of 1 in 1,000. Each of the tunnels would be 18 ft. in diameter, and would be driven, as in the case of the London tubes, by the Greathead shield. The grey chalk which underlies the white chalk, and through which it has been proposed that the tunnels should be driven, had, he said, been tested by some thousands of borings, and it had been proved that the strata on both sides of the Channel were identical. Beneath the grey chalk was, he continued, a formation of gault, very similar in character to the London clay, and the tunnels could be driven through that formation instead of the grey chalk if necessary. Sir Francis stated that the excavation would be carried out by revolving cutters electrically operated, and that, although the tunnels would be lined at the outset with iron segments, the permanent lining would be reinforced concrete. Connecting galleries would be provided, which could be utilized for the storage of materials, and water locks would be constructed so that the tunnel could be flooded if desired at any time. It is understood that the members of Parliament who have responded to a canvass on the question are nearly all in favor of the construction of the tunnel. Of 322 replies which have been received by the House of Commons Committee, 310 support the proposal, 8 are opposed to it, and 4 adopt a neutral attitude. There are, however, 228 members who have not indicated their attitude on the question.

Road Maintenance in Rural Areas

By JAMES A. WEBB,

From Journal Institution of Municipal and County Engineers.

Use of Refuse Destructor Clinkers in Road Work. Mr. Roberts, borough engineer of Worthing, stated that he had read the notes on tarred clinker, and could only say that the first road he laid—13 years ago—is quite good today. He has two roads in the center of the town surfaced with tarred destructor clinker which are narrow, and through which all traffic from Brighton enters Worthing in addition to the local omnibus traffic of 15 minutes' service. These roads were put down some 9 years ago with excellent results, proving that success has been achieved in urban roads in addition to roads in rural or outlying districts. Owing to the difficulty of obtaining granite chippings last year, crushed destructor clinker was used when tar-spraying, which made a fairly good surface at the time, but did not stand the wear during the wet weather in the winter anything like granite chippings. He has found that, if the tarred clinker is well looked after and is painted immediately any small cracks appear, the water is kept from entering the material. The hard frosts on several occasions during the last two winters did not damage the roads kept up in this way. He is gradually surfacing the whole of the roads in the borough with tarred clinker.

Mr. J. W. Birch, borough inspector, East Ham, states that broken destructor clinker has been used on various roads in East Ham, and except under very heavy traffic has given satisfactory results. Some experimental pieces have been laid in the following manner:

(a) Broken tarred clinker, about 1¼-in. gage, laid about 2 in. thick, topped with ⅜-in. tarred broken clinker on existing flint road surface.
(b) Broken tarred clinker, about 1¼-in. gage, laid about 2 in. thick, and topped with ⅜-in. tarred slag on existing flint surface.
(c) Broken tarred clinker, about 1¼-in. gage, laid about 2 in. thick, and topped with existing granite, surface (after being sifted), the granite being laid dry and grouted with bituminous material.
(d) Broken clinker, about 1¼-in. gage, laid dry, topped with existing granite surface (after being sifted), the whole being grouted in with pitch grout to within ½ in. of the surface, after which it was floated over with bituminous material and blended in with ⅜-in. granite.

Items (c) and (d) have been laid on the breast of the road alongside the tramway track, over which there is a frequent service of motor 'buses. The pitch grout was made at the destructor works and consists of pitch, oil and flue dust from the destructor flues. In breaking the clinker down to 1¼-in. gage a fair amount of small sizes clinker is obtained varying from 1 in. down to a very fine clinker resembling dust, which has been utilized in the following manner:

1-in. gage is used for the top portion of the sewage filters.
⅜-in. clinker is used for:
  (a) Covering tarred surface of roads.
  (b) Gritting roads during winter in time of frost.

A disdvantage was experienced in using ⅜-in. broken clinker for road work, as it contained a considerable number of nails and small pieces of iron. The council recently purchased an electro-magnetic separator. The ⅜-in. and fine clinker is passed over this separator, which eliminates all metallic substance, thus allowing this material to be used for road work. The amount of current taken by the separator is 1½ units per hour—240 voltage.

The very fine clinker is used as follows:

(a) Mixed with cement, it is laid on the public footpaths (in situ).
(b) Mixed with cement in the manufacture of drain inspection chamber covers (when fixed in public footpaths) the same being reinforced with old iron and steel.
(c) Filling in manhole covers in place of wood blocks.
(d) Binding in tar dressing of school playgrounds.
(e) Mixing with ballast for concrete in lieu of sand, when ballast is not suitable owing to the amount of loamy hoggin, which is sifted out, this leaving clean stone.

The clinker and cement used in lieu of wood blocks for manhole covers increases the weight of the cover by about 33 lb [illegible] The following formula [illegible]

	Per cent.
Bitumen soluble in C S 2	[illegible]
Passing 200 mesh	18.00
[illegible]	8.60
[illegible]	4.65
[illegible]	16.15
[illegible]	[illegible]
Retained 10 mesh	[illegible]
	[illegible]

[illegible] Road Surfaces. Many of the roads in Norfolk County are surfaced with flints, and in [illegible] road surfaces ensues. This is especially noticeable where the subsoils are [illegible] preventing the surfaces breaking up, suitable binding has to be applied as soon as the surfaces become bare. Granite surfaces are treated in a similar manner when the necessity arises.

Roads, especially where the subsoil is of chalk—and there are many instances of this in the county—suffered very considerably from the action of frost during the past winter. The surfaces became blown, and in some instances were completely cut through. Where this occurred the material had to be taken out to a depth of from 9 in. to. 12 in., and the defective section made good with suitable material.

The effect of heavy traffic depends largely on the nature of such traffic and the climatic conditions prevailing at the time. Timber haulage appears to cause more damage to road surfaces than any other type. Especially is this the case if carried out immediately after the frost.

The Effect of Tarring Surfaces of Roads Constructed.—(1) Gravel; (2) granite (water-bound); (3) slag (water bound).

1. The success or failure of tarring gravel surfaces depends to a great extent on the character of the traffic, nature of subsoil, surroundings and gradients. Efficient surface-water drainage is essential if satisfactory results are to be obtained. Under favorable conditions this treatment the author finds has added to the wearing qualities and prolonged the life of gravel-surfaced roads.

In pre-war days about 170 miles of granite-surfaced roads were tarred annually with very excellent results. Since this period about 80 miles only have been treated each year in consequence of many sections not being in sufficiently good condition, due to the causes previously given. This the author considers a highly satisfactory method of dealing with road surfaces, especially from an economical standpoint.

Very good results have been obtained from tarring roads surfaced with slag. The life of this material is considerably prolonged in consequence of this treatment.

Treatment of Repairs (Potholes).—Owing to the prevalence of potholes, repairs have had to be carried out extensively. The practice is to have the surface of the road where repairs are required well swept. A coating of tar is then applied and on this granite chips of suitable gage are laid, care being taken to leave the pitch level with the surface of the road, with a view to avoiding a bumpy or uneven surface. Very good results have been obtained by using beach shingle, which wears remarkably well. In instances where there are a number of potholes in close proximity, the spaces between the potholes are picked up, and a continuous patch laid.

COMPARATIVE COSTS, ETC., BETWEEN PRE-WAR AND PRESENT TIME.

Cost of granite per ton, carriage paid...	12s 6d	18s 6d
Cost of flints per ton, carriage paid	[illegible]	6s 6d-7s 6d
[illegible]	[illegible]	[illegible]-2s 0d
Horse, cart and man per day	6s 0d	12s 6d
Two horses, cart and man per day	10s 0d	18s 6d
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible] 5s 4d
Number of roadmen employed	700	300
Steam rollers at work	14	7
District surveyors (12 main road districts)	12	8

The Transmission of Heat Through Heavy Building Materials

From Engineering, Dec. 27, 1918

A Bulletin* recently issued from University College gives a description of certain experiments carried out by the Department of Heating and Ventilating Engineering of University College of the University of London.

The objects of the experiments, as stated in the Bulletin, were:

1. To develop standard methods of testing the heat transmission through thick walls with such accuracy as to ensure that uniform results can always be secured from separate tests of the same wall, and that the causes of variation in results of different tests from the same wall can be investigated.

2. To compare the transmission coefficients for different materials under precisely defined standard conditions, and to verify the applicability of formulae in current use.

3. To measure the degree of variation in the amount of heat actually transmitted in different conditions through walls exposed on one side to the outside atmosphere.

In a short preliminary discussion of heat transmission through a wall it is pointed out that a wall separating two masses of air at different temperatures (1) absorbs heat by contact of air, by radiation, and "sometimes in other ways"; (2) this heat is transmitted by conduction through the wall; and (3) the transmitted heat is given out by three distinct processes: (a) Convection currents; (b) evaporation of moisture; (c) radiation.

A formula due to Dulong and Péclet, is given for the loss by convection for "still air," showing this to be in proportion to the power 1.233 of the difference in temperature between the surface and the air. An approximate formula for the heat radiated is also given showing that this is proportional to the difference of the fourth powers of the absolute temperatures of the outside of the wall and its surroundings; and it is pointed out that with a difference of only 30° F. the heat given off by radiation would be about 30 per cent of an average total value. Evaporation is, however, the most difficult factor, and it is practically impossible to deal with this matter otherwise than in a general way.

Having pointed out the great complexity of the problem and in consequence having shown the incompleteness of the ordinary theory in which the resistance to the flow of heat is assumed to depend on three different constant resistances, namely:

(1) From the inner air to the inner surface of the wall, α_1.

(2) From the inner to the outer surface of the wall, e/C.

(3) From the latter to the outside air, α_2.

the authors conclude that a complete treatment is impossible and that the ordinary theory is the best that can be developed for practical purposes. Their endeavors are therefore directed towards finding the values of α_1, α_2, C and K, where C is the conductivity of the material of the wall of thickness e and K is the overall coefficient of transmission connected with the other constants by the relation

$$1/K = 1\alpha_1, + 1\alpha_2, + e/C.$$

which is easily derived.

The general principle of the experiments was to apply heat to a portion of the inside of a wall at such a rate as to keep the inside air temperature, t_{i_2}, constant and equal to the room temperature over a long period and to measure the outside air temperature, t_o, at intervals in the same period. Then with the assumptions made above if W is the whole heat supplied in H hours to the area A sq. ft. of the wall $W = K\ A\ H\ (t_i - t_o)$, K being in B.T.U. per sq. ft. per degree F. difference in temperature per hour. Similarly, $W = \alpha_1\ A\ H\ (t_i - T_i) = \alpha_2\ A\ H\ (T_o - t_o)$ where T_i and T_o are the inside and outside temperatures of the wall, which are also measured to find α_1 and α_2; and C is given by $W = C\ A\ H\ (T_i - T_o)/e$.

Actually the experiments were carried out by fixing to a portion of the wall under test a chamber, of which the wall is made to form one side, which is otherwise closed, and which, along with suitable instruments, contains a resistance by which means electrical energy is dissipated inside it. The temperature of the air inside the chamber being kept within narrow limits equal to that of the air round the chamber the energy introduced into the chamber will obviously have to pass through the wall. In these conditions the authors state that the stream lines of heat will be perpendicular to the wall surface, but it is clear that this will only be true for one definite distribution of relative temperature on the outer surface of the wall, and as this is not in any way controlled in one set of experiments the necessary distribution of temperature is not likely to exist. It is readily seen that if one side of a wall is kept at a steady temperature while the other side is exposed to the varying conditions of the atmosphere the ideal steady state will never be realized, and therefore only rough determinations of K are possible.

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*University of London, University College, Department of Heating and Ventilating Engineering. Bulletin No. 2. "Report of Research on Transmission of Heat Through Heavy Building Materials." By Arthur H. Barker, B. A., and M. Kinoshita, M. Sc.

The tests made belong to three different series, the first of which were made on an old 9-in. brick wall plastered on the inside with ¾ in. of plaster. The wall was the outside wall of a first floor room; it faced westwards; it was somewhat sheltered by surrounding three-story buildings, but was otherwise freely exposed to atmosphere. The object of this series of experiments was to obtain mean and extreme values of K under ordinary varying atmospheric conditions. Actually the wall was kept heated continuously for some seven weeks in February-March, 1914, and the data obtained were broken up into 13 periods varying from 25 to 60 hours during each of which periods the weather conditions were more or less uniform. Throughout, the temperatures of the air in the room and in the chamber were kept between 60° and 61.5° F., and the mean outside temperature varied from about 40° F. to 60° F. From the data thus obtained values of K are found varying from 0.25 to 0.59, the "weighted" mean being 0.40, which is some 22 per cent greater than the figure generally used. The prevailing weather conditions were recorded and they are given, and it appears from these that wind and rain tend to give higher values for K, while sunshine tends to give lower values. The maximum value 0.59 is associated with an average rainfall of 0.37 in. per day, a southwest wind of 21 miles per hour (No. 5 on the Beaufort scale) and no sunshine; while the minimum value of 0.25 is associated with a rainfall of 0.17 in., a wind velocity of 5 miles per hour (No. 2) and an average sunshine of 5.2 hours per day.

From this series of experiments the authors conclude (1) that the currently accepted coefficients are some 25 per cent too low if applied to an old wall, and (2) that for such weather conditions as prevailed during the experiments the maximum rate of heat loss is some 45 per cent above the mean rate. They point out that figures of general applicability could only be obtained as the results of many more experiments made on different types of walls of different ages, in different localities, and extending over very long periods.

The experiments which constitute the second series were made for the purpose of comparing various building materials with regard to the transmission of heat through them when placed in exactly defined and identical constant conditions. This requires the establishment of the "steady state" which means that the experiments must be carried out in the laboratory. For this purpose there were erected two exactly similar walls, 6 ft. sq. by 9 in. thick, of unplastered plain stock brick built with the Flemish bond, exactly facing each other, the inside surfaces being 9 in. apart. The experiments extended over a period of about 5 months, and readings were only taken after the structure had been heated for about 72 hours by which time it was found that the "steady state" had been approximately reached. The results give a mean value for K of 0.421, the maximum and minimum values being 0.443 and 0.383, respectively. The conductivity is found to be 0.657 and α_1, and α_2 1.45 and 1.84. Since the earlier experiments in this series give considerable higher values of K and λ (the conductivity) than the later ones the conclusion is drawn that this is due to the drying of the wall by constant heating, and therefore that the effect of dampness in a wall may be taken to increase the average emission by as much as 50 per cent. It is also concluded that for a new dry wall the value of K given by Rietschel is about 10 per cent too low.

In the experiments which constitute the third series one of the brick walls used in Series II was retained, while the other was converted into a 9-in. match-boarded wall. Twenty-six different experiments were made on the combination from which it is found that for the match-boarded wall K is 0.250; the maximum and minimum values being 17 per cent and 16 per cent above and below the mean. From this it follows that the resistance to the transmission of heat through a 9-in. brick wall lined with wood ⅝ in. thick with an air space of ⅞ in. is about the same as that of a brick wall 21 in. thick.

It is finally concluded from the second and third series of experiments that the ordinary theory of transmission with constant conductivity and constant surface resistances is approximately true—a conclusion of considerable practical importance. The mean values adopted for a plain 9-in. brick wall are K, 0.43; α_1, 1.5; α_2, 1.9; and λ, 0.66. The value of the resistance of a single wood partition ⅝ in. thick is about 0.56.

It appears to us that the accuracy suggested in these figures is much above what is practically useful. We think that exposure to the weather and the deposition of soot and dirt on the wall would sensibly alter the values of α_1 and α_2 and therefore of K. The general object of the experiments is presumably to obtain information which may be used in the design of heating installations. In these the capacity must be such that a proper inside temperature may be maintained irrespective of the outside weather conditions, which may be severe over sevaral days, which means that not mean but extreme values of the coefficients are the more important.

Increasing Strength of Wood Paving Blocks By Impregnation

In Zeitschrift für angewandte Chemie, of Oct. 11, 1918, W. Riter discusses attempts made to increase by impregnation the strength of wood paving blocks. Tests were made of crushing resistance calculated per sq. cm. on prismatic blocks 75.75 sq. mm. in base area and 120 mm. in height, the pressure being applied in the direction of the fibers. Experiments in which sodium or potassium carbonate and sodium silicate in various proportions were added to an impregnating bath of pine-wood tar showed no advantage, but increasing the temperature of the bath with the dry samples gave a 12 per cent increase in strength. Experiments were also made by substituting heavy coal-tar oil for the wood tar at temperatures from 112° to 140° C. At the higher temperature these trials gave as good results as those with wood tar, but the blocks impregnated at the lower temperature showed a crushing resistance inferior to that of the untreated blocks. Sodium carbonate alone, or, still better, sodium silicate alone, gave more favorable test results than the mixture of carbonate and silicate. The chemical composition of the impregnating bath, however, is of less importance than its temperature. The temperature should not be carried above 200° C. on account of the danger of splitting the blocks. The best strengthening results are obtained by impregnating for three hours with gradual increase of temperature up to 200° C. A test block showed a crushing strain of 323 kilos. per sq. cm. in the untreated condition; this was increased by impregnation at 100° C. to 330 kilos., at 120° C. to 345, at 140° to 487, at 150° to 516, and at 200° to 536 kilos.

Cohesion in River Mud

A letter in Engineering, March [illegible], 1919

In the course of some recent computations as to accretion and scouring, a serious error in the text-book methods came to my notice. It is customary to assume that the velocity required to roll or transport small particles decreases indefinitely with the size of the particle, but as a matter of fact a stable bed is possible in mud as well as in fairly coarse sand with a bottom velocity in both cases of, say, 3 ft. per second. This is undoubtedly due to the cohesion of the mud, and is concomitant with its fineness, so that there is a minimum velocity or erosion for all river beds. If we compute the drag per unit area on the bed from the usual rules for fluid friction it will be found that when the particles are small the force per particle may be as little as 10^{-8} dynes. This is about the cohesion bond between two molecules, so that the whole particle (perhaps several million molecules) can be retained by one pair of cohesing molecules.

This explains the well-known stability of mud channels which has been observed in Egypt, India and China.

HERBERT CHATLEY,
Whangpoo Conservancy, Engineer-in-Chief's Office,
Shanghai.

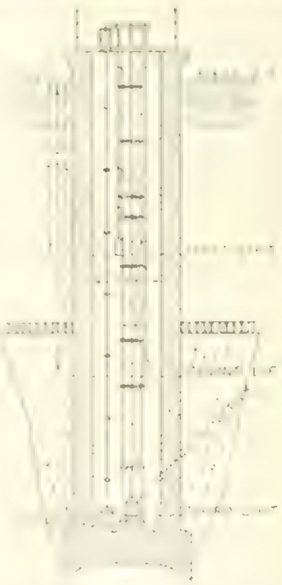
The Freezing of a Reservoir Outlet Works

[illegible] Irvine and [illegible]

[illegible]

[illegible] the discharge from a reservoir through the freezing of the [illegible] works on Jan [illegible] so far as the author [illegible] of a similar expe- [illegible] and Coal [illegible] the shaft and stand- [illegible] urned upwards. [illegible] serve to show [illegible] was not [illegible] shaft at the author's works; [illegible] similar conditions [illegible] elsewhere, the au- [illegible] ns on the probable [illegible] tion, hoping that the record [illegible] to be of interest and utility to others.

[illegible] from two impounding reservoirs on different gathering grounds, the top water level of the Caaf reservoir being 510 ft. above O. D., and that [illegible] 317.5 ft. above O. D. Both are [illegible] catchment area is of a peaty description. The usual practice is to run all the [illegible] reservoir, and draw the whole supply from Munnoch to the filters in order to keep the quality of the water as constant as possible throughout the whole district. The Caaf water can also be supplied direct to the main pipe from Munnoch reservoir to the filters through a by-pass connected below the Munnoch reservoir. The Munnoch is the oldest reservoir of the works, and was commenced in 1875. The total consumption of water is about 5,500,000 gal. per day.



Section of Munnoch Valve Shaft.

The illustration shows a section of the Munnoch valve shaft, which has an open grating extending to the bottom of the shaft, which is 43 ft. below T. W. L. On the inside of this grating copper wire netting of ¾ in. mesh is fixed.

At 6 a. m. on January 25, 1917, the filter keeper reported by telephone that water had almost ceased to flow in all the pipes from the reservoir to the filters, and that the clear water tanks were considerably down. Men were dispatched to inspect the pipe tracks, and others, including the author, proceeded to the Munnoch reservoir. On arrival at Munnoch it was found that the keeper was not aware of anything wrong. The men who inspected the tracks reported all right. Inspection of the shaft, however, revealed the fact that air was rushing into the standpipe, and the interior of the shaft was evidently empty of water as far down as could be observed for ice. Soft ice was adhering in large quantities to all the inner walls of the shaft to the protruding parts of the standpipe fittings, and also to the copper screen in front of the shaft, where it was about 12 in. in thickness, and formed a curtain completely preventing water from entering the shaft. The two top lift valves had been open, and the subsequent opening of the bottom one made no improvement.

To restore the supply a large proportion was turned through the by-pass pipe from the Caaf reservoir into the outlet pipes, immediately below the Munnoch reservoir, whence it passed through the standpipe into the Munnoch reservoir until it released the ice to some extent from the sluice valves and bottom of the screen. The direction of the Caaf water was then altered to pass down the pipes to the filters along with that which could be got through from Munnoch. Men were also told off to remove the ice on the outside of the screen with spades, etc., work which had to be continued until the weather became quiet and a skin of ice formed over the whole surface of the reservoir.

On the evening of Jan. 13, 1918, under similar weather conditions, a recurrence of this phenomenon was reported, and, as before, resulted in a complete stoppage of the supply of water to the filters. Several degrees of frost had been almost continuous for two or three weeks, and a skin of ice was formed over about two-thirds of the area of the reservoir. The remaining part was open water all round the region of the shaft. A strong northeast wind prevailed, keeping the open water much disturbed, and as it was blowing towards the front or screen side of the shaft, it caused the soft drift ice to cling to the screen. On this occasion the bottom and middle lift valves had been left open with the object of drawing the water as far as possible from the bottom of the reservoir, where it would be at a slightly higher temperature than at the surface. This precaution, however, again proved valueless as a means of preventing the entire choking of the screen with ice.

It can scarcely be doubted that the trouble experienced was caused by the formation of ice in a crystalline form throughout the unfrozen area of the reservoir, a process resulting from and greatly accelerated by the low temperature coinciding with the agitation of the water by a strong wind. Owing to the consumption of water in the district having enormously increased, the quantity drawn from the reservoir was more than double that for which the works were originally constructed. This heavy draw through the standpipe caused the loose masses of frazil ice near the surface of the water, and of almost equal density with it, to be carried towards the wire screen and valves, and to which it adhered in an irregular manner until there had been built, from the top downwards, an ever-hardening wall sufficient to stop percolation. This will be more readily understood if it is considered that on account of the unusual conditions of the weather the water in the reservoir had fallen to a very low temperature, and on approaching the shaft and going through the screen would be very nearly 32° F. As the temperature of the water was probably lowered still further in the shaft, the formation of frazil ice would be quite uninterrupted, it having been found by experiment that a reduction of 0.1° F. is sufficient to cause the formation of frazil ice.

To find a quite certain means of prevention under such circumstances would be extremely difficult, but no doubt it would be an advantage to reduce the rate of flow under similar circumstances by drawing the water from each reservoir separately. As, however, the trouble was perhaps primarily due to the existence of the area of agitated open water round the shaft and the consequent production of frazil ice, the author considers that the early formation of a sheet of surface ice covering the water in the immediate vicinity of the shaft would most probably be an effective protection against the recurrence of the phenomenon. The formation of such a sheet of ice over the disturbed water might be induced by floating light wooden hurdles on its surface. Ice would be readily formed in the comparatively calm water which would exist between the hurdles, and with this barrier once established it is probable that no further trouble would be experienced. These are the only means of prevention which suggest themselves to the author at all likely to prove an adequate safeguard against a similar occurrence in the future, and if adopted at the commencement of a cold spell when the conditions are favorable to the formation of frazil ice in large quantities, they would in all probability secure the desired protection with a minimum of labor and of expense.

Standardization of British Railway Equipment.—The advisory council under the Ministry of Reconstruction has reported that immediate steps be taken to carry out standardization of railway equipment. The council recommends that the standardizing of wheels, axles, wheel centers, tires, running gear, drawgear, buffing gear, bogies, brakes and underframes be dealt with at once by the Engineering Standards Committee.

The Reinforced Concrete Dome at Hippodrome, Copenhagen

From Concrete and Constructional Engineering

To construct a dome on a solid centering is a comparatively simple matter, and it is therefore of interest to state that this example, which is entirely of reinforced concrete (a material in which the centering is the chief objection raised against its use) was constructed with far less timber work than would have been required for a dome of stone or brickwork.

The dome, which covers the new Hippodrome at Copenhagen, has a span of 130 ft., and approximates more to saucer than basin form, which incidentally means greater normal thrusts on the outer or containing walls of the building.

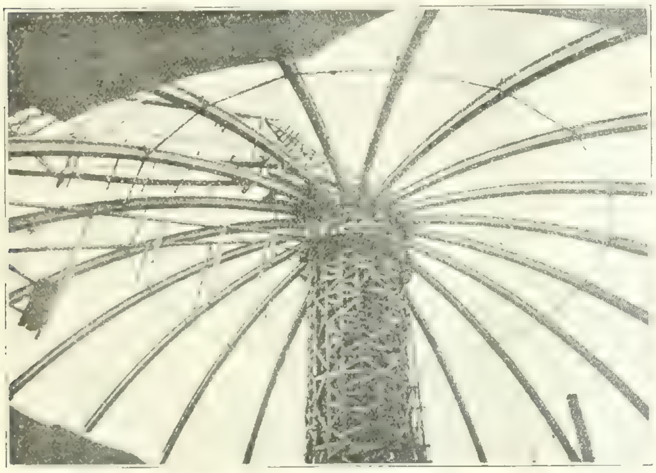


Fig. 1—Reinforced Radial Ribs in Position.

Its method of construction is shown in Figs 1 and 2 In the exact center a timber gantry tower was built, and on and around it a continuous reinforced concrete apex ring was formed, whilst a springing ring was constructed on the top of the containing wall of the building.

The dome itself is formed on a system of radiating ribs or arched beams filled in with reinforced concrete panels or slabs. The ribs, of which there are 20, are of H-section, and were constructed on the ground and hoisted into position. Between them three rings of stiffening beams were constructed (see Fig. 2), and the 89 intermediate bays were formed as simple panel fillings with reinforcement both ways and across diagonals.

The completed dome is finished with asphalt. The concrete work was designed and executed by Messrs. Christiani & Nielsen, of 25 Victoria St., Westminster, S. W.

Wood-Concrete for Houses

The possibility of the application of wood-concrete to the construction of houses and other buildings is discussed by a writer in Beton und Eisen of Nov. 2, 1918. Being called upon to build a floor in a malt-house at short notice, he proposed the use of wood pillars surrounded by concrete, as wood alone could not be used, owing to danger of rotting. He does not think there is any difficulty in obtaining the necessary static co-operation between the wood and concrete, and quotes some investigations of another investigator to support his view. It is necessary that the wood be dry, and, if possible, suitably impregnated before concreting, though care should be taken to see that the impregnating does not affect the concrete.

It is necessary to take into account the different coefficients of thermal expansion of wood and concrete in considering the applicability of the system to a particular purpose, otherwise the advantages of wood-concrete may be outweighed by the disadvantages. In general, the system is more suitable where no other material is available. So long as the wood-concrete does not present objections from the static standpoint, the wood-work must be dimensioned as would be the case if wood alone were used. In the actual system increased dimensions are necessary throughout the building, owing to the space lost on account of the heavier nature of the structure generally. The advantages of wood-concrete, in the author's view, are rapidity and cheapness of construction, the possibility of immediately placing such structures under load; the fact that alterations and even demolition can be carried out at a low cost, and that the wood recovered in the latter case can be used again. Wood-concrete is therefore more applicable to buildings of a more or less temporary nature, and where fire risks are not great.

The writer gives a rough plan showing the construction of a dwelling house on the above system. He recommends the use of sheet-iron shells or casing in building up the structure, as they can be removed and used for the next highest stage in the process. It is more satisfactory to use very weak mixtures for the purpose under discussion, say 1 to 15. If slag sand and gravel of fine consistency is used for the concrete, and the cement content kept low, as just suggested, the thermal conductivity of walls, etc., built in this manner is low, so that there is little loss of heat from the interior.

Although the author has only dealt with dwelling-houses, he sees no reason why the system should not be extended to the construction of bridges, wood towers, and water-cooling towers.

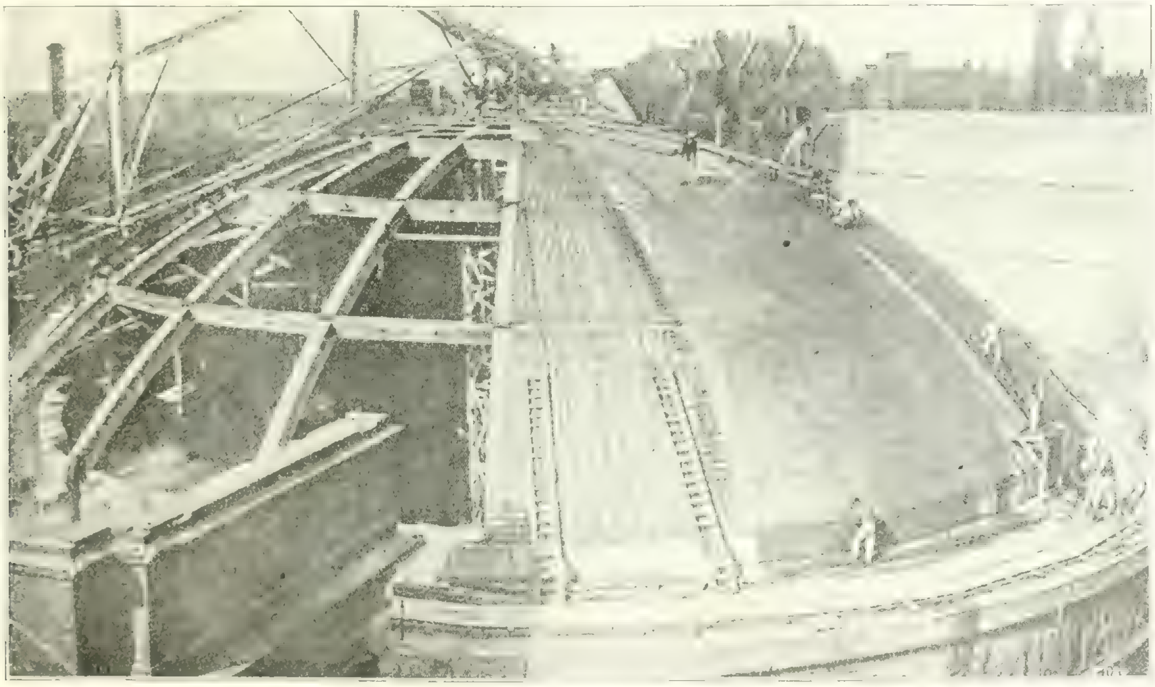


Fig. 2—Ribs in Position and Reinforcement of Panels for Dome Over Hippodrome at Copenhagen.

Use of Sludge as a Fertilizer

By [illegible]

[illegible]

[illegible] general [illegible] method can be adopted [illegible] sludge disposal [illegible] the same composition and very few [illegible] for its disposal be- [illegible] very seldom the same. [illegible] economically [illegible] may have no land for the purpose, or, if he has, it may not be suitable.

[illegible] should make [illegible] his own particular works, find out any peculiarities or any special qualities, and make [illegible] that he can adopt, [illegible] possible for profit. It is for this reason, then, that I will try to confine my remarks to the efforts, experiments and results obtained in [illegible] the works of which I am in charge.

[illegible]	For a population of 21,000
[illegible]	[illegible] gal. per annum
[illegible]	Approx. 1,000,000 gal.

The works are situated ½ mile from center of town and directly opposite to a large hospital, so it is essential to keep smell at a minimum.

There are six sedimentation tanks about 60 yard from busy main road. The tanks are constructed at a lower level than the reservoir for the sludge, all the sludge having to be [illegible].

There are 6 acres of land in conjunction with the works suitable for the disposal of sludge; 2½ acres of this are adjoining the sludge reservoir and 3½ a short distance away. When I was appointed some nine years ago, the 3½ acres were let at a very low rental and the 2½ acres were growing wild.

The sludge question was recognized as the bugbear of the place—a new works laid out three years previously on the most up-to-date biological principles. The 500,000 gal. of liquid sludge was being carted away in tub-carts to any place where the carters could find a dumping place. The cost of [illegible] £4 per week for carting alone, and the return from it—nil. The cost of carting nowadays would be nearer £8 to £10 per week.

My first idea was that as the sludge contained a large amount of excreta (the sewage being domestic, with very little trade waste), there must be some value in it as a manure. The land was taken over and the overgrown land cleaned and cultivated, and this was used for experimental purposes in the growth of various vegetables, etc., using only sludge as manure.

Now, much has been said and written about the use of sludge as manure, and in many cases people have endeavored to point out that it has little or no value; but on the other hand the opinion of some managers and others who deal with this sludge is in a different direction, and they say that when applied to the land in a proper manner it has a value. They say they can prove by practical results that it is of more value than one would think from the figures of analyses.

I do not wish to state generally that sludge is of any great value as a manure—it would be too contradictory to very many eminent persons' opinions; but my opinion is that there is some value, and I am led to say this only by the results I have obtained.

I have previously stated that it is up to each manager to adopt the best and most profitable means at his disposal. In my case these are by applying to land the sludge in liquid form. There are, very fortunately, the 2½ acres of land which gradually slopes from the sludge reservoir. This land is plowed and worked in the usual manner, except that the furrows are made a little deeper than in usual practice. The more working the land has the better it seems to suit the crops, as no doubt the air and bacteria become more active in the soil.

The ridges are planted with brassica and potatoes. While the crops are on the land the liquid sludge is run into the furrows by letting it overflow as it is pumped into the reservoir into a system of cross-gutters. When the land is clear of crops it is plowed, and the sludge evenly and thinly distributed over the surface. The cost of this is very little. For instance, the sludge pump is driven by a 11-h.p. gas engine, and the cost of so disposing of 77,000 gal. from June 3 to June 6, 1918, was actually—

	£	s	d
[illegible] 1,000 [illegible] per 1,000	0	15	0
[illegible]	0	1	0
[illegible] the sludge on land and empty [illegible] tank, 1 man, [illegible] days at 6s	1	4	0
[illegible]	0	12	0
	£2	12	0
Therefore, [illegible] gal. (12 months' production) could be so disposed of, the cost equals	£16	18	0
[illegible] previous cost of £4 per week for carting [illegible]	208	0	0

There is the cost of working the land, but the amount realized from the sales of crops from this plot was over £100, which more than pays for that.

The 3½ acres are a short distance away, but the method adopted is quite similar, but this costs a little extra as the sludge has to be carted away in tubs. When conditions are favorable it is allowed to follow the furrows, but when not it is stored in a tank, the floor and sides of which are constructed of house refuse and ashes. Here the sludge dries, and when suitable is spread about the land. It further dries, and in the course of the ordinary working of the land, plowing, etc., it is thoroughly incorporated into the soil.

I give the land a dressing of lime—5 cwt. to the acre—between the months of January and March.

Last season's result from all crops from 12½ acres of land, with only sludge and storm-water as manure, was £530.

Made up as follow:

Mangolds, 7 acres	£317	13	7
Swedes, 2 acres	79	16	0
Cabbage, 3 acres	110	13	8
Potatoes, ½ acre	22	9	8

This is by far the best result obtained, although the amount has gradually increased annually for the last eight years.

On a small scale I have tried dried sludge mixed with superphosphate, basis slag, potassium sulphate or chloride, ammonium sulphate or bone meal. The mixture gives better results bulk for bulk than if sludge is used alone, the quantities added depending on the condition of the soil. The mixtures were very suitable for cabbage, swedes, potatoes, peas and beans, meadow hay and pasture land.

Mangolds and beet did better with a small quantity of salt added.

In each case the ratio of superphosphate, bone or basic slag, mixed with sulphate of ammonia or sulphate of potash, was somewhere about 3 of the former to 1 of the latter.

Another substance tried with good result was wood ashes.

Setting and Hardening Processes of Concrete

From Zeitschrift für Angewandte Chemie, Oct. 1, 1918

The constantly widening use of cement has made it necessary to seek fuller knowledge of that material from the standpoints of chemical constitution and chemical changes; the nature of the changes it undergoes in the process of setting and hardening and its weaknesses relatively to outside destructive influences.

As a constituent of cement, recent research into the formation and constitution of blast-furnace slag has revealed facts which enable us to choose that form of raw material more intelligently. But there is need for much more laboratory work in that direction. What actually takes place in the processes of setting and the subsequent hardening is yet but imperfectly known. Recent observations with the microscope have, however, thrown some light on these matters. By coloring some of the constituent materials, the results of chemical reaction may be seen. The first action in the setting process appears to be a crystallization of calcium silicate needles and calcium aluminate tablets. When this relatively rapid process of crystallization is complete, but not till then, a mass of calcium silicate is formed. The hardening process rests upon the separating out of this silicate which binds together the crystals and makes the whole insoluble in water. The formation of the silicate goes on so long as there are lime, free silicic acid, and water in contact. The chemical resistance of cement to sea water has been tested to some extent; but our knowledge of the chemical and mechanical influences at work is yet but scanty. Systematic research is possible only in the laboratory furnished for that purpose. It will be for the recently formed Scientific Committee of German Cement Manufacturers to find the necessary means for this work.

Education and Training of Municipal and County Engineers

From The Surveyor—Discussion last December at special meeting of Institution of Municipal and County Engineers.

Mr. Arthur E. Collins, M.Inst.C.E., past president and chairman of the board of engineers of the institution, gave it as his opinion that an entrant to municipal and county engineering should be a youth of good character, manners, health and education, who had matriculated or passed an equivalent qualifying examination. If he had been educated at a public school it would be to his advantage. He should be articled to a municipal or county engineer for three years. The first year should be spent in the practical work of his master's department, including drawing office, surveying, laying out and supervising of works and workmen, and visits to engineering workshops. The office experience must include correspondence, accounts, time-keeping, specifications, quantities and routine work. In a year a general knowledge of routine and practice should be obtained. The pupil should then proceed to a university for a three years' course, preferably one in which there was a chair of municipal engineering. At the expiration of this course he should return to his master and complete his articles. In some towns it was possible to serve articles and attend a university concurrently. In the opinion of the writer this was not as advantageous as the course already outlined, as the office and class hours must clash. Again, with some universities it was possible for the practical office and works experience to be obtained in the summer half of the year, and to attend the university in the winter. The general principles underlying engineering were the same for all, but the municipal branch of the profession required particular study of the following subjects and facility in their application: Office and works organization; prices and costs of works; designs; specifications; reports and clear exposition to committees, etc. The practical engineering subjects included geodesy, sewerage and sewage treatment; waterworks, water supply and distribution; tramway construction; road construction, maintenance and cleansing; collection and disposal of domestic refuse; building construction and materials; drainage, heating and ventilation of buildings; town planning; municipal and public health law and by-laws relating to the above subjects; the general principles of architectural design. A municipal engineer should have somewhat more than a bowing acquaintance with chemistry and bacteriology, so that he might fully grasp the meaning of reports of chemists and bacteriologists on questions of sewage, water, materials and so forth. It was very obvious that a municipal or county engineer qualified on the lines sketched was a very valuable member of society, who should be honored and rewarded accordingly.

Mr. F. Wilkinson, borough engineer of Deptford, gave it as his opinion that the ideal education for a young man was for him to get his degree or diploma for engineering by the time he was 18 or 19 years of age. That would give him a sure foundation in the principles of mechanics and other subjects on which to build a sound practical training. Then he should commence a two to three years' apprenticeship in an office, so as to finish when he was 21, his further technical education then to run concurrently with his pupilage, so that by the time he was 23 he would be able to take the Institution of Municipal and County Engineers' examination and successfully cope with it. If the institution did not raise this examination to a higher level, he felt that the future would offer no inducement for a young man to enter the profession, and if this were not done they would never get the status they were aiming at.

Mr. C. Brownridge, borough engineer at Birkenhead, said that, in contradiction to Mr. Wilkinson, he would suggest that the pupil or apprentice should get his general theoretical and scientific education done with before he entered an office, and then devote himself more or less to applied science specially applicable to the work he had to do in the office. They were all familiar with cases of pupils who had obtained the qualifying diploma to take their own examination or the examination of the Institution of Civil Engineers, having to apply themselves to scholastic studies which ought to have been finished with before coming to the office. The municipal engineer had always to be a student; consequently they ought not to expect their apprentices to understand everything appertaining to the profession. His view was that general education in the future was going to be different to what it had been in the past, and it was going to be such as to enable any youth with brains or ability to pass examinations such as the institution examination. They wanted to encourage youths with brains, and brains should be the qualification. That being so, he would like to say that in dealing with the question of the education of the pupil, they also be required to watch over what he would term the pupil farm. There were offices in which an undue number of pupils were taken with the object of getting premiums. These youngsters were not dealt with fairly, and on being thrown onto the market did not do credit to the profession. Mr. Collins had outlined a six years' pupilage. That was too long. The first year he should serve in a municipal or county engineer's office. He would there give power to either the master or the pupil to determine the artilces, because while a youth might think at first that he had a liking for municipal engineering, he might later find that it was different to what he expected. He agreed that the next two years should be spent at the university or a proper technical institution where the youth could get a good grounding in science, but at the end of the period the youth with ability—natural ability—would have become a most useful member of the office staff, and would in due course come into touch with all the subjects Mr. Collins had outlined. In any case he doubted whether any youth after the completion of three years in the manner he had suggested would be willing to serve a further three years in the office unless the question of payment was dealt with. In his concluding remarks Mr. Collins had expressed the opinion that a municipal or county engineer qualified on the lines which he had sketched was a very valuable member of society, and should be rewarded accordingly. That was very important, but if their assistants were going to be paid a less wage than a carter, one could not expect many to join the profession, and anything the institution could do in the direction of improving training and remuneration would be a most useful work.

Mr. W. Jones, deputy borough engineer, Deptford, submitted the following communication: In order to get a satisfactory road a good foundation is necessary. This maxim is also applicable to the profession of a municipal engineer and surveyor. In order to get a good engineer and surveyor, a proper foundation is absolutely essential, and in this case it should be the standard of education which should be insisted upon before any person can be allowed to enter the profession. The examinations I would suggest are the London Matriculation or Oxford or Cambridge senior examinations. Some engineers insist on an intended pupil qualifying at a university as a Bachelor of Science before commencing his articles. The parents in this case are put to a considerable unnecessary expense, and the benefits derived by the man in after life under the present system do not warrant any such expense. Say the student leaves school at the age of 16 years, by the time he has got his degree and served his period of articles, he is at least 22 years of age, and then was offered in pre-war days, the glorious sum of 25s to 30s. per week, with annual increments of £10 per annum to encourage him to improve his knowledge. Such appointments were generally advertised at a certain figure per annum because it sounded so nice to the ears as a lump sum. If this amount was worked out at so much per week, then it turned out to be a paltry sum, even lower than a stonemason's, or in some cases a laborer's wages. The civil engineers' examination seems to be the hall-mark of our profession, but why it should be I do not know. It is to be hoped that at a time not very far distant the Institution of Municipal and County Engineers' Examination will be raised to a much higher standard than even that of the civil engineers, and there is no reason (provided of course the present system is revolutionized) why this should not be. There are several ways in which the status of the municipal engineer and surveyor could be raised in the immediate future, and I beg permission to enumerate them briefly: The examination of the Institution of Municipal and County Engineers should be a hall-mark of our profession, and the standard should be raised in the following ways: (a) That the entrance exam-

[illegible] should be passed by the [illegible] and this should be [illegible] (b) The board of exam[illegible] and eminent gentlemen [illegible] of the institution. (c) Ex[illegible] which completely em[illegible] works which [illegible]r is called upon to perform. At the present time [illegible] the institution answer the [illegible] to my mind. I would suggest that applicable sub[illegible] by the following [illegible] Engineers, (b) Sur[illegible] of Civil Engineers, (d) [illegible]. The examinations [illegible] to be passed in a [illegible] than one year. The student could thereby qualify [illegible] (d) No member should in the [illegible] to the institution with[illegible] laid down by the insti[illegible] the candidate [illegible], and after pass[illegible] transferred to the class [illegible] (e) The present list [illegible] who have not passed [illegible]ination of the institution or qualified as associate [illegible] of the Institution of Civil Engineers, or passed the [illegible] Institution examination, should be given a speci[illegible] say two years, in which to qualify as a member under the existing examination conditions. If these members do not qualify in this period, their names should be removed from the register. The suggestions given above may [illegible] but I am of the opinion that only very strong measures are of any use if the future of the young engineer is to be safeguarded. Now is the time for action, [illegible] * * * My suggestions would do away in time with the so-called engineer and surveyor of the road foreman type, whom we often meet in smaller boroughs, because each small urban or rural district could at all times have a young engineer, properly qualified, who has had a good education and sound practical training. Security of tenure could be got much easier if such conditions could be brought about.

Mr. J. Sutcliffe, borough engineer of Woolwich, expressed the opinion that the profession had been deteriorating for a good many years previous to the war, and he could best indicate his own attitude by saying that, while he hoped his own son would become an engineer, he had made up his mind that he would not be a municipal engineer. He did not stand alone in that; many of his brother engineers were of the same opinion, but he thought that the lessons of the past three years provided a great opportunity for giving a filip to the profession of municipal engineering.

Salaries of Some English Assistant Surveyors

From The Surveyor, Jan. 24, 1919.

At a recent meeting of the Southwick (Sussex) Urban District Council, Father Smith drew attention to a recommendation by the committee that the assistant surveyor's salary should be £2 ($9.72) a week. The committee also recommended an increase to scavengers which would bring up the latter's wages to £1 17s. 6d. ($8.06) a week. Surely there was something disproportionate in their estimation of values. The assistant surveyor had just been released from the army, and he thought some better appreciation should be shown of the services of a young man who was an efficient official, and who had served his country than to pay him the same salary as the scavengers received. After discussion, it was suggested that the matter should be taken back by the committee for further discussion, but the chairman thought it ought to be settled forthwith, and on his proposal it was decided to pay the assistant surveyor £2 10s. ($12.00) a week, war bonus inclusive.

At Bingley Urban District Council a motion was made to fix the salary of an assistant surveyor at 58s. ($14) per week. Mr. T. Turner strongly protested. The young man had worked for the council for 5 years without wages, and now it was proposed to give him 4s. (96 cts.) more than a carter. It would be a disgrace to any council. The matter was ultimately referred to the Wages Committee.

Damage to Road Surfaces by Heavy Vehicles

From The Engineer, Feb. 21, 1919.

The recommendations in the report of the Local Government Board's Departmental Committee on the use of road locomotives and heavy motor cars, included an increase in the permissible weight of locomotives fitted with Boulton wheels from the present standard of 14 tons and up to 18 tons. This concession was suggested by the evidence of several experts, who said that Boulton wheels caused less damage to road surfaces than any other form suitable for heavy traffic. In this connection the findings of the committee as to the damage caused to various kinds of road surfaces by different kinds of traffic are of considerable interest. The evidence from which the conclusions were drawn was to some extent contradictory, but the balance of opinion appears to show that in the case of paved roads, such as stone blocks or wood, or asphalt, laid on concrete foundations, the damage is largely due to iron and steel tired traffic; that as regards block-paved roads on concrete, while many instances of damage caused by iron and steel tired traffic have been brought forward, none the less, several surveyors regard this form of construction as suitable for heavy traffic generally; and that, given a surface kept in a reasonably smooth and level condition, rubber tired traffic appears to have no serious effect upon block-paved roads, even when traveling at a high speed.

Given a properly maintained surface, wood paving on adequate concrete foundations is not damaged to any material extent by either class of heavy traffic. It is true that some specific instances of damage either to the wood surface or to the foundations have been given, but in some of these cases, at any rate, it would seem that the damage has been mainly due to the worn and uneven surface of the pavement. Under similar conditions, natural or rock asphalt on concrete is not seriously affected by either class of traffic, although one instance of damage caused to this class of pavement by the steel tired heavy motor traffic was brought before the commitee. As regards the more modern forms of road construction in which tar, pitch, or bitumen is used as a binder or matrix, the evidence is conflicting, but there would appear to be no doubt that roads of this class, if properly constructed and maintained, will carry a considerable volume of heavy traffic without undue damage. In the case of water-bound macadam roads the damage is mainly due to rubber tired traffic.

The principal causes to which the damage of the roads can be ascribed are, the committee thinks, in the case of traction engine traffic: (a) The weight of the engine, and of the loaded wagons which it draws; (b) the haulage of exceptionally heavy pieces of machinery or similar loads on trucks having iron-tired wheels of small diameter; (c) the use of driving wheels fitted with diagonal cross bars and of steering wheels fitted with narrow bands; (d) the slipping of the driving wheels in the efforts of the engine to haul a heavy load; (e) the use of wagons, generally, with wheels of small diameter.

In the case of heavy motor traffic the damage is attributed to: (a) the laden weight of the motor vehicle and the uneven distribution of the weight over the axles; (b) the use of wheels of small diameter; (c) the propulsive effort of the vehicle; (d) the fact that, owing to the camber of the road and inequalities in the surface of the road, the full width of steel tires does not come into contact with the road surface; the weight is thus concentrated upon the part of the tire actually in contact with the road surface, and the sharp edge of the tire cuts into the road; (e) the action of the solid rubber tire as it expands and contracts when coming into contact with, and leaving, the road surface; it is contended that in the case of water-bound roads, for example, this action of the tire has a disturbing effect upon the road surface, that the materials of which the road surface is formed are loosened and forced out, and that in the case of the twin rubber tire the materials are "pinched" or "squeezed" between the two tires as they expand; (f) the hardness of the solid rubber tire, when worn; (g) the impact and the speed, more especially when there are inequalities in the surface or potholes due to lack of repair; (h) the disregard of the regulations limiting weight and speed, and the failure to enforce them. In addition, special damage is attributed to motor omnibus services by reason of: (1) the regularity of the service, namely, the constant passage over a road of vehicles of identical construction, and the frequent stopping and starting of the omnibuses, often at fixed points along the road; and (2) the character of the load and the springing of the vehicle.

Decorating and Coloring Walls with Cement

From Il Cemento.

The application of a covering of cement or of ornamental works made of this material to the walls of buildings should only be done in spring or autumn and in damp, cool weather, because it is most difficult in hot weather to secure adequate adhesion as the cement dries too rapidly. If the work must be done during the summer, the walls must be protected in the best possible way from the direct rays of the sun, and kept damp until the coloring has taken well. Particular care must be taken to have the surfaces to be covered with cement absolutely free from dust and dirt; they should be well washed and afterwards damped repeatedly. New cement work does not adhere to dirty surfaces, and those which absorb water too quickly often cause cracks in the new work, and the coating does not acquire that complete hardness and resistance on account of the continual absorption of the water preventing the cement from setting properly.

Walls made of bricks which do not resist frost or which exude acids are not adapted to be covered by cement; porous walls must be completely protected from dampness; otherwise the layer of cement would easily detach itself under the action of frost. If the cement contains too much water it is spoilt. It should be prepared as a homogeneous mixture, so as to avoid the cracks which occur with layers of uneven thickness and irregular composition. The cement must not be too soft when used for covering walls exposed to the action of atmospheric agents, as thick coatings under such conditions have a great tendency to crack. The greater the proportion of sand employed in coating without affecting the necessary resistance, the greater its resistance to atmospheric influences. Hence a sufficient quantity of fine sand should be added, so as to obtain a very plastic cement, the plasticity being added, if necessary, by the addition of a little lime.

The surface may be finished smooth by the use of iron discs. A trowel should not be used, because the surfaces so finished are uneven in thickness, are often too thick and are more sensitive to the action of frost, and therefore to cracks. To cover a cement surface satisfactorily with oil colors the first condition is that the cement must be quite dry and fully set. Oil colors applied to a fresh surface are not durable and resistant, because the alkali and the hydrate of lime in the cement decompose the oil. When interior walls are to be covered they must be frequently watered until the complete setting of the cement is assured; they must afterwards be dried before applying the oil color. It is sometimes desirable, if the coating color has to be applied quickly, to wash the cement repeatedly with very dilute sulphuric acid— i. e., one part of commercial concentrated sulphuric acid to 100 parts of water. This solution transforms the alkali and lime into inactive sulphur compounds. Alternately, the well-known fluorides or fluates, especially fluoride of magnesium, may be employed, as they convert the lime into inert fluosilicic acid, which has the further advantage of increasing the density and hardness of cement coating.

The treatment with a fluoride (fluate) is as follows: The cement surface must be sufficiently dry. Then fluoride of magnesium is mixed with 10 times its measure of water and applied with a paint brush. After 20 to 24 hours the operation must be repeated with a solution of double strength. Two or three hours after the second coating has been applied the cement will be ready. It may be tested by applying the tongue to see if it has an acid flavor; this indicates that a sufficiency of fluate has been used. Alternatively, a damp piece of blue litmus paper should be pressed with a cork against the fluoridized surface. If the treatment has been sufficient the paper turns red. Otherwise the treatment must be repeated until this result is obtained. Afterwards the surface must be thoroughly washed, dried and then covered with oil color.

Reinforcing System and Concreting Machine for Reinforced Concrete Roads

Two features of interest in connection with concrete road construction by the Port of London Authority are a system of reinforcement and a concrete mixing and placing machine. Both of them were designed and patented by J. H. Walker of the Port Authority. The following description is abstracted from Concrete and Constructional Engineering:

Reinforcing System.—The system of reinforcement was the outcome of the difficulty foreseen in laying a concrete road upon the particularly soft ground of which the land in the neighborhood of the Victoria Dock is composed. This system provides for top and bottom layers of reinforcing bars combined and interlocked with zigzag diagonal tension members in such a manner as to form a rigid mattress to which any additional bars may be attached as required. This is shown in Fig. 1. One of the advantages of this type of reinforcement would appear to be that it forms a convenient means of putting to good use such old scrap material as wire-ropes, barbed-wire, etc., which can readily be cut to convenient lengths and wired on to the framework where desired.

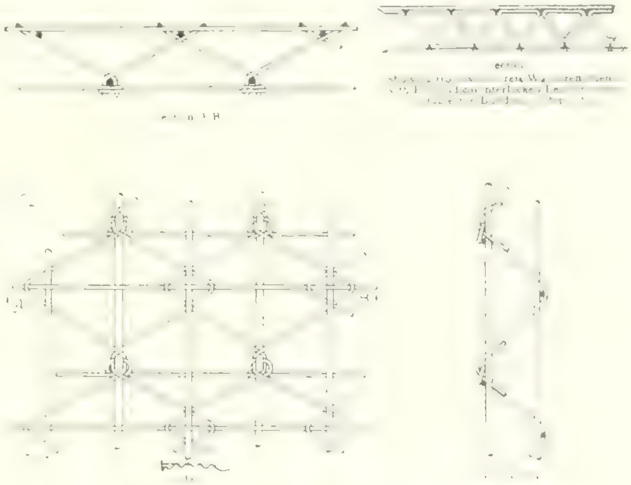
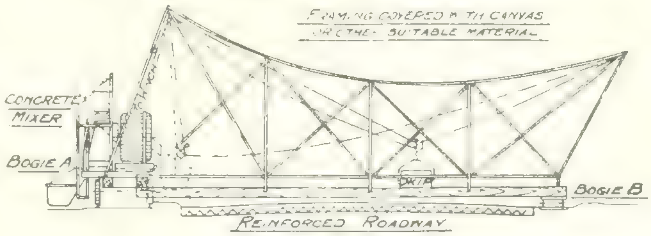
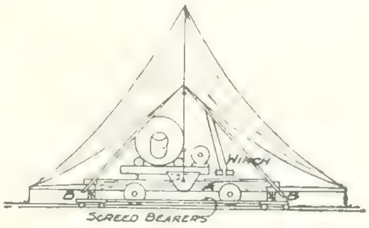


Fig. 1—Pyramidical Interlocking Reinforcement.



SIDE ELEVATION



END ELEVATION

Fig. 2—Sketches of Concrete Laying Machine.

Concrete Mixing and Placing Machine.—This consists of a ½-cu. yd. concrete mixer and an electric winch with two drums for operating a skip running along a cable-way so that the material may be deposited with ease and rapidity at the spot required. The cable-way is attached to a framework over which canvas or other suitable material is spread for the protection of the newly laid concrete. The road surface is screeded to finished levels by means of a double-handed screed depending from supports on the framework of the machine in such a manner that the usual wood striking strips are [illegible] can be laid [illegible] to [illegible] carried [illegible] the labor [illegible] concrete is very [illegible] warmed by [illegible] fact that a [illegible] weather [illegible] the road being [illegible]

[illegible] and the thickness [illegible] coat of 2 in., [illegible] shingle graded [illegible] the proportions adopted are 1 part Portland cement, 1.25 parts sand, and 2.5 parts shingle. Some months after being laid and when the concrete had [illegible] road was tar sprayed and [illegible]

To Raise Status and Further Interests of Engineers

[illegible]

[illegible] the status and further the interests of members of the engineering profession?

[illegible] for this purpose must necessarily be a trades union, and in spite of past failures [illegible] any good and valid reason why engineers should not be able to combine successfuly to form a powerful association for the maintenance and anvancement of their own interests. Nor does there seem to be any reason why such a body of educated men should not, by their combined efforts, attain the same objects as have been attained by other bodies of educated men—notably those engaged in the practice of law and medicine.

It is true that at present there is in the engineering profession no fixed standard of training and attainment short of which a man ceases to be recognized as a qualified engineer, but at one time the medical and legal professions were in the same unorganized and chaotic state, and their members labored under the same disadvantages that engineers find so detrimental at the present day. Is it not possible for engineers to follow in the footsteps of these two organized bodies? It seems to me that if they started on a sufficiently broad and democratic basis, instead of wasting time and energy in fruitless efforts to form and bolster up small associations with purely sectional interests, success would be assured. The formation of small bodies to advance the interests of small sections of the engineering profession, such as have been attempted in the past, is a movement foredoomed to failure under present conditions.

All professional engineers, whether civil, mechanical or electrical, have a common interest in the advancement of their social and professional status, and there does not seem to be any good reason why they should not all combine for that purpose. Such a combination would be unassailable in its strength and quite capable of advancing the sectional, as well as the common interests of engineers in general. Medical men, for instance, have not wasted their energies in an attempt to form separate and independent associations for those who specialize in the different branches of medicine and surgery.

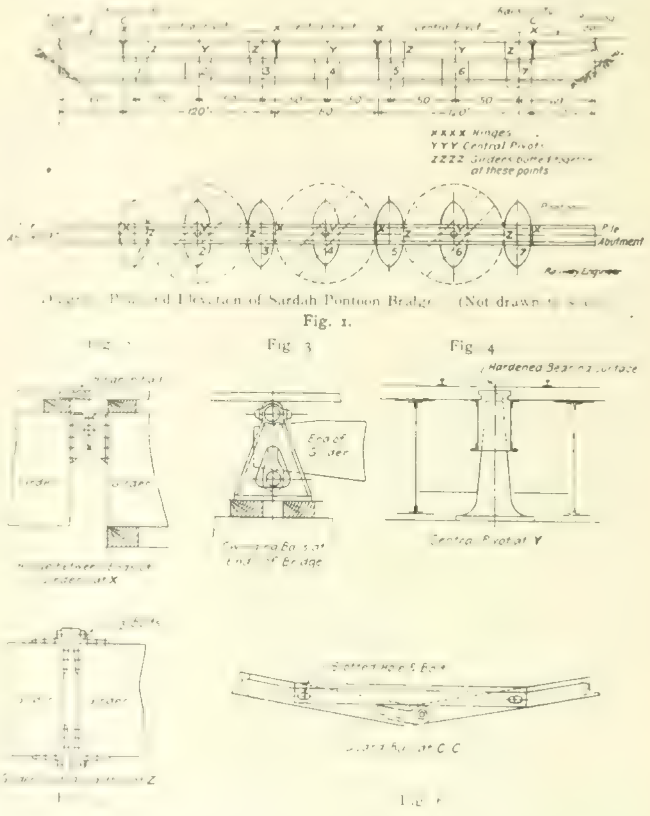
Employers and manual workers are both formed into powerful federations, and unless staff engineers and officials throw aside their individualistic tendencies and take combined action they are likely to suffer sore attrition between these upper and nether millstones. It is not possible for any engineer, no matter how experienced or gifted, to stand individually against a powerful confederation of employers, and the sooner this is generally realized the better it will be for the profession.

Benefits of Covered Reservoirs.—The water engineer of Aberdeen, Mr. Cecil H. Roberts, M. Inst. C. E., in his report for the year ending May 31, 1918, states that the benefit of covering the reservoirs and the effects of filtering continues to be noticed in the much greater cleanliness of the reservoirs and aqueduct, the number of cleanings necessary both of the reservoirs and of the aqueduct being less than half of what it was previously.

A Pontoon Bridge for Pioneer Railway

From The Railway Engineer, December, 1918

The Sardah (India) pontoon bridge was erected on the Dudwa branch of the Lucknow-Bareilly railway, and an interesting report on the principles of construction and method of use was published in February, 1895, and reprinted this year, by the Technical Section of the Railway Branch of the Public Works Department of the Government of India. The branch was made primarily to open up throughout the cold weather the Government forests of the Kheri district, from which large quantities of sal, asina, and miscellaneous timbers are annually exported. A boat bridge was formerly kept up over the Sardah river by the Forest Department throughout the cold weather, but when the branch railway was made it became at once necessary to build a bridge that would carry engines and loaded wagons at slow speeds. A pile bridge nearly 800 ft. in length was constructed in 1892 but was practically demolished during a heavy flood the same year.



Plan, Elevation and Details of Sardah Light Railway Bridge.

The present pontoon bridge is 420 ft. in length, and is composed of five spans of steel girders supported on two abutments and in the stream by seven steel pontoons. The railway is of metre gage.

Although the pontoons are all of the same size, and are equally spaced at 50 ft. distances centers, the girders are not of the same length, but vary in lengths respectively, being 50 ft., 120 ft., 80 ft., 120 ft., and 50 ft., as shown in Fig. 1.

It is not intended to use the pontoon bridge at all during the hot weather or at times when the high water level is reached. At such times the water overflows the banks and reaches nearly 10 ft. above the cold weather level of the river, and nearly 4 ft. above the fixed rail level at the two abutments. The river is not at the same level all the time the bridge is in use, and, in fact, a range is provided for of 2 ft. 6 in., that is, 6 in. below the normal level and 2 ft. above it. The inclination of the span at either end is therefore always altering. As designed, the end spans rise towards the river at an inclination of 1 in 30, giving a rise of 1½ ft. from the abutment to the first pontoon on each side.

The first pontoon sinks nearly to this amount under the moving load, and the rails are thus level for the advancing train. Should the water level be 6 in. below the normal the sinking of the pontoon will be the same as before, but the inclination of the rails in the end span will then be 1 in 100 downwards on to the pontoons. On the other hand, should the level of the river be 2 ft. above normal when the train is to pass over, the pontoon will sink again the 1½ ft. and the rails in the end span will rise from the shore on to the first pontoon again at an inclination of 1 in 100, which gradient for a length of 50 ft. only can be easily overcome. With this varying inclination of the end spans in view a horizontal hinge is provided at the first pontoon on each side, see Fig. 2.

The girders are rigid over the next three pontoons, and are made 120 ft. long with this in view, so that one of the three outer pontoons cannot sink without assistance from the other two. The central 80 ft. length of girder is hung on horizontal hinges at each end, besides resting in the middle over the central pontoon. With this arrangement of pontoons and hinges the flexibility of the girders is assured, and at the same time one pontoon is made to assist another throughout the passage of the engine and its train of loaded wagons. The intensity of the load will vary along the length of the train, making a certain amount of vertical flexibility essential unless the girders had been made very much stronger. No horizontal flexibility is provided in the bridge, and as the pontoons are always securely anchored when the bridge is in use there can be no horizontal movement other than the difference in length of the mooring chains or ropes due to their varying inclination owing to the rise and fall of the pontoons. This has, however, been found not to present any difficulty.

At the two abutments, where the ends of the girders rest on timber piles, suspending links or rocking bars (see Fig. 3) are provided to permit the longitudinal play of the girders caused by the rise or fall of the pontoons due to passing loads or changes of water level, and so that the system of girders and pontoons can swing altogether longitudinally. How this possibility of endwise movement of the bridge as a whole between fixed abutments affects the permanent way of the bridge, which must be rigid as regards the length, is not stated in the report.

But there are also vertical hinges, or points of bearing (see Fig. 4) upon the alternate pontoons Nos. 2, 4 and 6. Over each of these alternate pontoons an 80-ft. length of girder can revolve by means of this central pivot from crosswise to lengthwise of the boat, in order that when the bridge is dismantled for the flood season the pontoons with the parts of the bridge upon them can lie snugly anchored against the banks of the river. The report does not say what becomes of the shore spans when the pontoons are away.

The 120 ft. lengths of bridge over pontoons Nos. 1, 2, 3 and 5, 6, 7 are in three lengths, a central length of 80 ft. swinging on the central pivot over boats 2 and 6, and two ends of 20 ft. each carried on the outside boats of the three. These various lengths are connected rigidly to one another when the bridge is "put up," and disconnected when it is "taken down." A sketch of this rigid butt joint is shown in Fig. 5,

The pontoons are each 50 ft. long, 20 ft. wide, and 5 ft. deep, and weigh about 15½ tons each. They have a displacement of 750 cu. ft. for each foot of draft, corresponding to 20¾ tons. The weight of each pontoon with its superincumbent load is about 29 tons, corresponding to about 1 ft. 5 in. displacement, which was observed in the actual structure. The pontoons are flat bottomed, and so possess considerable stability. When the bridge is "up" the center of gravity of each pontoon with its load is at about deck level. When the bridge is "down" or disconnected Nos. 2, 4 and 6 pontoons each have to support an 80 ft. length of bridge pivoted at their center, and in this case the center of gravity is about 6 in. above the deck, and this fact enables the different parts to be moved about without fear of capsizing.

To put up the bridge the pontoons are brought into position and the 80 ft. lengths of bridge swing abeam between the two 20 ft. end lengths, whose pontoons are loaded to make the draft of the three pontoons equal so that the connections can be made. The joints are then fitted together and bolted up, (see Fig 5) each joint being secured by five 1½ in. bolts, top and bottom, forming a rigid butt joint. The bolts are all easily got at, and the ends of the girders are easily fitted together in this way. The pontoons are moored by 8 in. ropes to anchors made of timbers and a rope net full of boulders, the guys being accurately adjusted by mooring screws fixed on the pontoons, and when once in line they seldom require readjustment.

There is no traffic on the river except during the rains, and consequently it was not necessary to provide an opening span.

The rails are of flat bottom section, and are hinged over the hinges of the girders to allow the same vertical movement. At the pontoon end of the outer span girders at the points C. C. besides the hinge a short length of rail 4 ft. long was secured by bolts having slotted holes, as shown by Fig. 6, to provide a sort of vertical curve in the rails. It had been noticed that without this short length of rail the middle wheels of a six-wheeled tender were hung up in the air. It had also been noticed that over this point there was a considerable vertical displacement between the wagon buffers, this amounting in some cases to 4½ ins. and caused an uncoupling of the wagons. It was to remedy this that the abutments were lowered to give an initial rise in line gradient from the abutment to the first pontoon.

The engine working the traffic over the meter gage has a weight of 15 tons and the tender 11½ tons, giving a total load of 26½ tons. The cars are of 10 tons loaded weight each. With engine and tender only, the first pontoon went down 0.99 ft., the second 0.47 ft., the third 0.31 ft., and the fourth 0.48 ft. With a train of engine, tender and five cars the maximum depression of No. 1 pontoon was 1.35 ft., the second 1.17 ft. the third 1.35 ft., and the fourth 1.24 ft.

With a train of eight loaded cars and a speed of five miles per hour the maximum depression of Nos. 1 and 7 pontoons was 1.83 ft.

These tests show that the outer pontoons in any case might with advantage have been made a little larger than the others. It is also evident that a train traveling at anything like speed would by the impact set the bridge rolling like a ship from side to side and make quick traveling very unsafe.

The Construction of a Dew-Pond: Water Without Springs, River or Rein

From The Surveyor, Feb. 7, 1919

At the Royal Institute of British Architects, Mr. George Hubbard, F.S.A., F.R.I.B.A., described how it was possible to obtain a water supply in the absence of springs, rivers and rains.

The atmosphere which was warmed during the day was, he explained, capable of containing a greater percentage of aqueous vapor than it could retain if it were chilled below the dew-point during the night, and the deposition of this vapor took place freely upon a condensing surface thermally isolated from the earth by a good non-conductor of heat.

In collaboration with his brother he constructed a dew-pond in a very low-lying piece of land to test the question as to whether it would be possible to obtain a water supply even under unfavorable conditions in the absence of rain, springs or streams. They began by excavating the earth over an area of 100 ft. square to a depth of 1 ft. 6 in.; over this they laid a bed of 4-in. of cement concrete and thickly coated the surface of this with pitch. The surface of the pitch was then spread over with fine sand, and mica slabs 2 ft. square and 2 in. thick were laid in regular order on top of the sand; about an inch space was left around each slab. In order to keep these slabs quite dry and so preserve their heat-non-conducting property, the whole surface of the pond was covered with ¾ in. of asphalt. The asphalt ran into the spaces between the slabs, but when it was completed it presented an even black appearance over the whole pond. At an early hour on an autumn morning, after a rainless night, the pond presented an extraordinary appearance. The whole surface looked like a chess-board with some 2,500 perfect white squares all ruled off regularly by hard pitch-black lines about 1 in. wide between them. There was very little dew on the grass around the pond, but in the pond, immediately above each mica square, tall white hoar frost was standing, but there was not a trace of hoar frost on the asphalt above the joints, which stood out as hard black lines. In a few hours the sun melted the hoar frost, and hundreds, if not thousands, of gallons of water lay in great pools and puddles on the surface of the pond.

Wind Pressures on 550 Ft. Chimney

[illegible]

[illegible] at Saganoseki, Japan [illegible] has given Professor [illegible] observations on [illegible] chimney is submitted [illegible] considerable interest, as [illegible] the degree of stability [illegible] an oscillation period of [illegible] in the case of the Saganoseki chimney, [illegible] a material that will give to the completed structure a degree of stability differing in [illegible] attaching to similar designs in brick or stone, mainly in consequence of the more [illegible] walls possible with reinforced concrete.

The shaft is the loftiest structure of the kind in the world, reaching a height of 550 ft. above the foundation pier. It stands on a hard Paleozoic formation whose seismic movement would probably be of less intensity than 500 mm./sec.², even in the case of a destructive earthquake originating in the neighborhood. The base is about 450 ft. above sea-level, and the top reaching therefore to a height of 1,000 ft. must experience a much greater wind velocity than that registered at the surface. The effect was sufficiently patent during the observations, and it is no exaggeration to assume that in time of storms the wind velocity at the top will be twice that at the base. The tapering form of the structure is clearly indicated in the following table:

[illegible]	External diameter. ft. in.	Wall thickness. in.	Ht. above ground of center of gravity of each portion. ft.	Volume cu. ft.
[illegible]	[illegible]	[illegible]	[illegible]	9,137
[illegible]	[illegible]	[illegible]	[illegible]	8,932
[illegible]	[illegible]	[illegible]	[illegible]	12,206
[illegible]	[illegible]	[illegible]	[illegible]	17,377
[illegible]	[illegible]	[illegible]	[illegible]	25,700
[illegible]	[illegible]	[illegible]		.....
[illegible]				73,652

The foundation, composed of reinforced concrete, is circular, 17 ft. in height and 95 ft. in diameter. Its weight is 4,714 tons, of which 4,603 tons are concrete, having the composition of 1 : 2 : 3.5, and the remaining 111 tons steel. The total weight of the main shaft is 4,852 tons, the reinforcement consisting of corrugated Johnson bars embedded in the concrete at the depth of 3 in. from the surface accounting for 316 tons. The total weight of the whole is therefore 9,139 tons, the pressure exerted by the main shaft being 3 tons per square foot, and the center of gravity of the whole is 194.2 ft. from the ground or about ⅗ of the height of the structure.

No external staging was erected, the materials and workmen were carried up by means of an elevator supporting a scaffolding 12 ft. by 12 ft., which at suitable intervals could be stayed against the interior wall of the chimney. The effectiveness of the arrangement is shown by the fact that the main shaft was completely erected in 190 days. This staging and its supports had not been removed prior to the observations, but could not have sensibly interfered with the vibration of the chimney shaft as the total weight was only 70 tons. Of more importance may have been the flue opening at the base, having a direction nearly W.N.W.-E.S.E., approximately parallel to that of the prevailing winds. The height of the flue is 31 ft. with a wall thickness of 3 ft. 6 in., and the opening at the base is 20 ft. in width with a semi-circular top of 10 ft. radius. The effect of this gap in the masonry is not negligible, and it is a little unfortunate that the range in the direction of the wind during the observations was too limited to permit fuller investigation.

The registering instruments consisted of two single component horizontal vibration recorders, one having half the sensitiveness of the other, each to be used according to the force of the wind. These instruments were oriented so as to indicate the vibration either in a radial or tangential direction. Two positions were occupied at the top of the concrete shaft. The variation in the force of the wind during the five days throughout which the observations were continued was considerable. On the first day a stormy gale with a velocity of 24 m. per second was recorded on a Robinson anemometer; then followed a period of three days with light airs, in which the velocity did not exceed 7 m. per second, but on the last day the weather was very strong, and the wind had the force of a hurricane, velocities of 35 m. per second or 78 miles an hour, being registered. The directions of the wind are not recorded further than that they coincide with the direction of the flue and that the air circulation about the chimney top was of a complicated character.

The following table summarizes the results of the five days' observations. A comparison between the results on the 22nd and 26th suggests that the motion on the latter date is too small. In another table, however, too long to quote, it would seem that the 20 mm. motion on the 22nd is a maximum and not an average excursion.

VIBRATION OF COLUMN NORMAL TO THE DIRECTION OF WIND.

Date, December, 1916. H. M.	Wind velocity. M. per sec.	Range of motion. Mm.	Complete period. Sec.
	6.9	0.18	2.55
Dec. 22 [illegible]	6.7	0.13	2.58
	5.5	0.17	2.55
Dec. 23 2 15 p. m.	4.5	0.11	2.51
Dec. 24 2 30 p. m. ..	1.0	0.13	2.53
Dec. 24..10 0 a. m.........	4.5	0.46	2.56
Dec. 25 11 0 a. m.	1.8	0.72	2.54
Dec. 26 [illegible] 0 p. m.	35.0	186.00	2.56

VIBRATION OF COLUMN PARALLEL TO THE DIRECTION OF WIND.

Date, December, 1916. H. M.	Wind velocity. M. per sec.	Range of motion. Mm.	Complete period. Sec.
Dec. 22 3 30 p. m.	22.0	20.00	2.56
Dec. 23 1 0 p. m.	1.0	0.47	2.52
Dec. 24 11 0 a. m.	1.0	0.24	2.53
Dec. 26 3 30 p. m.	35.0	20.00	2.54

Another fact of great importance made manifest by these figures is the rapid increase in amplitude with the augmentation of the wind's velocity. The simple formula that suggests that pressure varies as the square of the velocity does not hold here. With a velocity of 6 m./sec. the excursion is quite insignificant; at 24 m./sec. the complete range or double altitude is less than an inch; with the hurricane force of 35 m./sec. the motion amounted to nearly 8 in. Professor Omori is quite justified in asserting that with a wind velocity of 50 m./sec.—a velocity occasionally reached in gusts in this country—the chimney top would move at least 15 in. The period of oscillation in either direction does not vary with the amplitude, at least within the range of the present experiment, "probably because the motion was well below the elastic limit of the reinforced concrete structure." The mean period of the transverse oscillation, 2.55 seconds, is slightly longer than that of the parallel, 2.53 seconds, and if this difference be real, it may be traceable to the position of the flue, causing the shaft to oscillate more easily in the transversal direction, but the evidence is inconclusive.

Professor Omori has carried out similar observations on two other chimneys, at Skegawa and Tokio, each having a height of 100 ft. The general dimensions are as follows:

	External diameter. Skegawa. Ft. In.		External diameter. Tokyo. Ft. In.		Internal diameter. Skegawa. Ft. In.		Internal diameter. Tokyo. Ft. In.		Wall thickness. Skegawa. In.	Wall thickness. Tokyo. In.
Base	5	7	7	9	4	7	[illegible]	6	9	[illegible]
Top	4	0	[illegible]	1	3	1	5	6	6	5

The ratio of external diameter to height in the three cases is:

Skegawa ..	1:17.5
Tokyo	1:12.0
Saganoseki .	1:12.9

The instruments used on the two smaller chimneys were the same as on the higher, and the general arrangements nearly identical. Unfortunately, in both cases, the weather was too calm to permit of any decisive conclusions. At Tokio the wind had a velocity of only 5 m. to 6 m. per second, and the oscillations were very small. The vibration period was 0.85 second and the maximum motion 0.2 mm. At Skegawa a maximum velocity did not exceed 14.3 m./sec. and the mean was only 9.6 m./sec. As might be expected from the quoted dimensions, this latter column proved itself very shaky and, as a matter of fact, could be thrown into vibrations of considerable amplitude by the exertions of a man mounted on the top. With a wind velocity of less than 10 m./sec. the double amplitude amounted to nearly 1 mm., a considerably greater arc than in the case of the 500-ft. chimney. The interest of the measures consists mainly in comparing the effect of artificial shaking with that due to wind action. The former may have been increased by "resonance." The length of the arc through which the column moved, and the period of vibration were sensibly the same in the two directions at right angles to each other, so that it will be sufficient to quote the results derived from the vibrations transverse to the flue:

Date, 1917	Wind force and direction.	Effect of wind		Artificial shaking	
		Double amplitude.	Period.	Double amplitude.	Period
Jan.	M./Sec.	Mm.	Sec.	Mm.	Sec.
30, 3-3.30 p.m.	N.W. 7.6-14.3	0.95	0.81	4.3	0.81
31, 10-11 a.m.	S.S.E. 5.8-10.0	0.70	0.81	5.0	0.81
31, 11-12 a.m.	S.S.E. 5.8-10.0	0.90	0.82	8.4	0.82

The alternate growth and decay of the vibrations observed at Saganoseki was also remarked in the case of the smaller shaft.

The main conclusion reached is that wind pressure on a tall chimney can entail consequences as disastrous as those due to seismic motions, even in countries where such occurrences are frequent and severe. The observed motion of the Saganoseki chimney indicated a maximum acceleration of 565 m./sec.^{2}, whereas on the occasion of the destructive Tokio earthquake of June 20, 1894, the intensity was 444 mm./sec.^{2}. Should the wind velocity reach 50 m./sec. the vibration would acquire an acceleration of more than 1,000 mm./sec.^{2}. Only very near the epicentre of an earthquake is such an intensity to be anticipated. Again, a reinforced concrete chimney of less than 200 ft. in height must be regarded as a "short column," and in such structures it is desirable to reduce the height of the center of gravity as much as possible. On the other hand, the 550-ft. Saganoseki chimney, and still more that of the 1,000 ft. chimney already projected, must be regarded as "tall columns," that are seismically weakest, not at the base, but at about two-thirds of the height. In the usual chimney construction the center of gravity of the whole structure is situated at about one-third of the height, while that of the upper third portion alone, is nearly at the middle of its height, causing the shaft to be comparatively weak near the top. Professor Omori recommends such a distribution of the material, that the center of gravity should be at one-fourth the height of the whole structure, as well as for the upper portion alone. In such a case the chimney would present uniform strength against an earthquake shock. But if the center of gravity of the upper third part be about the middle of this section, the effect would be to weaken the shaft at the place where the seismic motion would be most effective.

Chalk Concrete Building Blocks

From Concrete and Constructional Engineering.

In the March issue of this journal last year reference was made to a form of concrete block construction invented and carried out in France by Captain Quick, R. E. Since that time a great advance has been made in this type of construction, blocks of different forms have been employed, and the product has been applied to a variety of uses.

In this system, the concrete was composed of chalk and Portland cement. The original block intended for walls of the pier and slab type was hollow and measured 10 in. by 10 in. by 2 in. The composition of the concrete, both for piers and blocks, is one part Portland cement and four parts chalk. The chalk is first thoroughly ground in a mill, and then the proper proportion of cement ground in with it. The mixture may then be made into a slurry, poured into molds and allowed to set; or it can be molded in a substantially dry state under pressure when it is said to be ready for use almost immediately.

In addition to the hollow blocks, which are used in two sizes, 10 in. by 10 in. by 2 in. and 9 in. by 9 in. by 4½ in., solid concrete bricks are made, 9 in. by 4½ in. by 3 in. These are molded with the aid of a French hand pressure machine, the mixture being in a semi-dry state, and variously proportioned from 1:4 to 1:10. It is claimed that the concrete bricks thus produced, and in the manufacture of which unskilled labor only is employed, are equal to the best facing brick made in this country, and at a cost well under that of the cheapest burnt brick. The buildings in the erection of which these blocks have been used have withstood the rigors of three winters, and we understand have shown themselves to be unaffected by frost or rain; experiments, too, have been conducted with a view to ascertaining the fire-resisting properties of the material, which, we are informed, were found to be very high.

As would be expected from the nature of the ingredients, this kind of concrete has a very fine texture, and it is said that when green it can be carved with ease.

British Joint Committee Report on Loads on Highway Bridges

From The Surveyor, March 7, 1919

The long-expected report of the Joint Committee formed in 1911 of members of the Concrete Institute, the Institution of Municipal and County Engineers, and the Institution of Municipal Engineers, dealing with "The Loads to be Provided for Upon Highway Bridges," has been published.*

The committee obtained information from a large number of surveyors, railway engineers, contractors and others, as to the weights of vehicles and the loads they carried, and after being fully considered the classification of the bridges was reduced to only three classes.

In designing bridges with cross girders, the committee says that the girders must be sufficient to carry the maximum axle load traveling across the center of their span at the given wheel gage, together with the dead load according to the spacing of the cross girders, and a distributed external load of 1 cwt. per foot super. over the area not occupied by the rolling load. In arched bridges the curve of the thrust should be drawn when the heaviest axle has reached the center of the nearer haunch and again when it has reached the center of the further haunch. These two positions probably give the greatest variations in the stress to be provided for, but if a third condition is taken, it should be when the heaviest axle has reached the center of the bridge. As regards the distribution of point loads through the thickness of the road material, the committee consider that the spread each way may be taken as equal to the depth, so that the pressure due to a wheel load of 5 tons, on a width of tire of 3 in. with a depth of road material of 12 in., would be spread over an area of 2 ft. 3 in. × 2 ft. = .1 1-9 tons per square foot on the under surface.

Effect of Speed.—The report deals with the effect of speed in increasing the vertical loads, and while correcting some exaggerated statements as the cumulative increase in loads due to high speed, says "that a critical speed exists at which the vibration and stresses induced by a rolling load reaches a maximum." The critical speed is different for various kinds of traffic and also depends upon the class of bridge. Up to now it has not been possible to formulate practical rules to determine even approximately the critical speed for a bridge, but it is suggested that experiments should be made to determine the critical speed for any particular bridge under test loads by which it would be possible to regulate the maximum speed for various kinds of traffic on the bridge. The committee is of the opinion that the condition of the roadway has more influence on the stress than the speed. The vibration of the load and consequent increase of stress will probably vary with the irregularity of the surface, and a very interesting table showing the tractive effort required on different road surfaces is given in the report. These vary from 40 to 50 lb. per ton of load on asphalt, 60 to 100 lb. on paved roads, 100 to 120 lb. on a good dry macadam road, rising to 220 lb. on a muddy road and 300 lb. on a loose stone macadam road.

The committee recommends that if bridges of over 50-ft. span are designed with a factor of safety of 4 and 5 for smaller spans, the loads may be taken as dead whatever the speed may be at which they are traveling. The dead load will include the whole weight of the superstructure, including mains, tramway rails, etc.

Standard Loads.—A table is given suggesting standard loads for the three classes of bridges, with diagrams showing typical maximum loads on each class of bridge. Class I. bridges are on main thoroughfares in great industrial centres and within 25 miles radius capable of carrying ordinary boiler trollies and heavy guns up to 25 tons on one axle, together with a tractor of 12 tons per axle and occupying a space of 40 ft. by 10 ft., with a load of 5 cwt. per foot super. on the gross area covered. Class II. are bridges on secondary roads in great industrial centres capable of carrying 20-ton rollers, large traction engines, tram-cars, etc., with a maximum axle weight of 15 tons and 2½ cwt. per ft. super. on gross area

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*"Loads on Highway Bridges." Report of Joint Committee. [illegible] Strand, London. [illegible] s. 6d. net, 2s. 8d. post free.

[illegible] on provincial roads other than [illegible] 12-ton rollers.

[illegible] be provided for in many of [illegible] in the North of England and the [illegible] axles with a wheel [illegible] This is the load on which [illegible] and loads of [illegible] for ordinary bridges [illegible] Docks.

Tires and Wheel Diameters.—An extremely useful appendix by Prof. Adams is attached to the report and deals with [illegible] of wheels for various roads. Although the committee decided that the consideration of [illegible] the scope of their inquiry, [illegible] appended to the report. The average standard width of tires now in general use is about [illegible] in. per 1 cwt., making no distinction between summer and winter, or between wheels of various diameters. This is [illegible] as the damage to a road surface decreases under the same load per inch as the width of the tire increases, and also as the diameter of the wheel increases. [illegible] must above all things be [illegible] Prof. Adams has therefore [illegible] his suggestions for maximum [illegible] graphically in a diagram, ranging from [illegible] 18 in. for a 30-ton load. He also gives a diagram showing the minimum diameter of wheel for a given load, and suggests that where the width of the wheel is over 12 in., twin wheels should be used giving half the width on each. In wet weather, say between November and April inclusive, the loads should be reduced one-fourth, so as to avoid damage to wet roads. He suggests that the length of a skid-pan should be three times the width of the tire, and be 1½ in. outside the tire and have rounded [illegible]

Machine for Tar Painting and Grouting

From The Surveyor, Jan. [illegible], 1919

[illegible] improvements in the "Non Such" tar-painting and tar-grouting machines (Sutcliffe's patent) are announced by the Patent Snowplow Co., Mytholmroyd, S. O., Yorks. The alterations in question are confined to the squeegees of the machine, which are now fitted in nine parts arranged in the manner shown in the accompanying photographic view, the idea being that each section will adapt itself to the camber of the road. As a result of the new arrangement the tar is pocketed and taken along by the squeegees, and a uniform distribution over a width of 6 ft. is secured. Some idea of the working capacity of the "Non-Such" may be obtained when it is stated that with a 160-gal. machine 800 gal. of tar have been applied in 9 hours. The actual time taken to apply 3 bbl. of tar is 8 minutes, and the yardage covered varies with the character of the road from 5 to 14 sq. yd. to the gallon; on this basis anything from 4,000 to 11,200 sq. yd. per day can be covered.

Tar Spreading Machine at Work.

Wind Bracing for 62 Ft. High, 378 Ft. Long Steel Warehouse

From The Engineer, Jan. 31, 1919

A warehouse, remarkable for its great height, and for the methods which have been adopted to make the structure capable of withstanding the wind loads, has been erected recently at Trafford Park, Manchester. The building was designed by Chas. Heathcote & Sons, Architects, Manchester, for the firm of Hall and Pickles, Limited, iron and steel merchants.

The building is of steel and 378 ft. 6 in. long. It is divided into four main longitudinal bays, 94 ft. 7½ in. span between the centers of the valley stanchions. The structure is 236 ft. 8 in. wide, divided into two equal spans, 118 ft. 4 in. between the centers of the stanchions, and the height is 62 ft. from datum to the level of the shoes of the roof principals. The principles on which the design is based are explained by means of the drawings, Figs. 1, 2 and 3, and the claim that this is the only structure in existence so treated for wind loads is probably justified. Before finally adopting the methods outlined below, a number of trials were carried out by the designers to ascertain the most reasonable and economical means of providing against the enormous wind pressure on a building of such large dimensions in an exposed position. This pressure, as will be seen from the drawings, was disposed of by transmitting all side wind pressure to the gables and all gable wind pressure to the sides of the structure, through a series of bracings in the roof—on the plane of the bottom ties of the roof principals—in the sides and in the gable ends. The wind load on each side stanchion having been calculated, one half of it was considered as acting at the base of the stanchion and the reacting face of

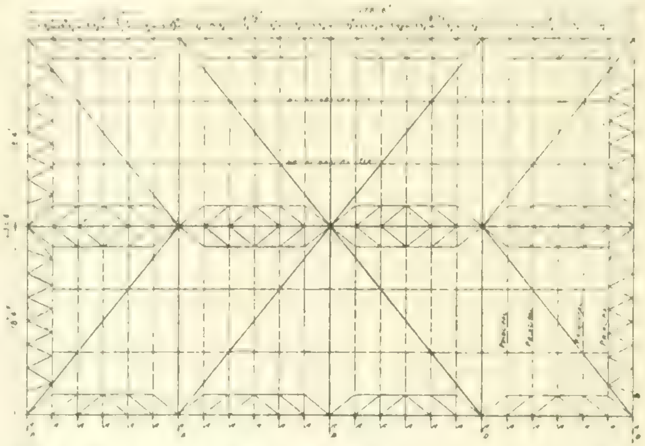


Fig. 1—Roof Plan of Steel Warehouse, Showing Wind Bracing.

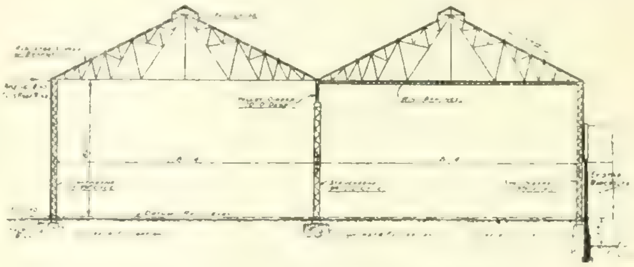


Fig. 2.—Cross Section of Warehouse.

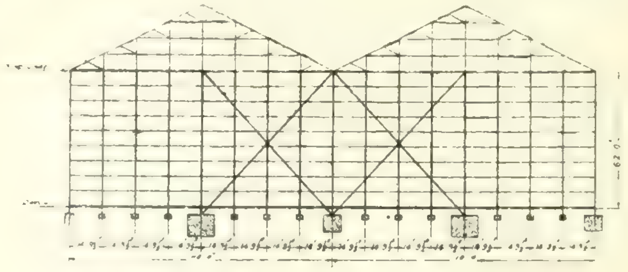


Fig. 3—Gable Ends, Showing Bracing.

the concrete foundation was made of such size as to offer a sufficient area to the adjoining ground to prevent sliding. The other half of the load, together with wind on the roof, was considered as acting at the head of the stanchion at points A indicated in the roof plan Fig 1, transmitted thence to points B through the horizontal trusses—of which the bottom ties of roof principals form the struts and additional members form the ties—and thence to points C through the horizontal truss, of which the top boom of the valley girders forms the bottom tie, the struts and diagonel ties being formed of lattice construction suspended from the bottom ties of the roof principals. The drawing (Fig. 2) shows how these stresses were provided for, and brought to the ground by means of ties introduced into the gable construction. Somewhat similar treatment was followed in connection with gable wind, the pressure being transmitted to the ground through gracings in the sides of the building. It will be noted that valley wind is also accounted for.

The general contractors were Messrs. J. T. Hollinworth & Son, of Patricroft, and the contractors for the steel work Heenan and Froude, Limited, of Manchester.

Reinforced Concrete Pontoons at Sydney, N. S. W.

From The Engineer, Oct. 4, 1918

The following particulars of the ferro-concrete pontoons for ferry berths Nos. 6 and 7 at Circular Quay, Sydney, New South Wales, will doubtless be of interest. One of the pontoons has a length overall of 110 ft., a maximum breadth of 67 ft. 7 in., and a depth of 7 ft. 9 in. The thickness of the bottom, sides and deck is 5 in., while that of the bulkheads is 4 in. The pontoon is divided up into 44 water-tight compartments. The total quantity of concrete employed in the structure was 342 cu. yd., and the amount of steel reinforcement used was 43 tons. The displacement of the pontoon when launched was 625 tons, while the displacement when it was completed with sheds, ramps, etc., was 783 tons. The reinforcement of the bottom is double, and consists of an upper and lower mesh. The upper is formed of ⅜ in. diameter rods arranged at 3 in. centers longitudinally, with ¼ in. diameter transverse rods at 3 in. centers. The lower consists of ⅜ in. diameter rods laid longitudinally at 6 in. centers, with ¼ in. diameter transverse rods at 6 in. centers. The two meshes are connected by No. 6 gage wire stirrups spaced at 6 in. centers and bound with tie wire to the rods. The reinforcement of the sides and ends is also double mesh, the inner mesh consisting of ⅜ in. vertical rods at 3 in. centers with ¼ in. diameter rods at 3 in. centers placed horizontally, while the outer mesh is made up of ⅜ in. diameter vertical rods placed at 6 in. centers, and ¼ in. diameter rods at 6 in. centers. Both meshes tied together at 6 in. centers with No. 6 gage wire. The bulkhead reinforcement consists of a double mesh with ¼ in. diameter rods spaced at 3 in. centers vertically and 6 in. horizontally with stirrups at 6-in. centers. The deck reinforcement consists of a double mesh made up of ¼ in. diameter rods at 6 in. centers both ways, tied together with stirrups at 6 in. centers.

The girders in the bottom and deck, both longitudinal and transverse, are 12 in. by 10 in., and are reinforced with ½ in. and ⅜ in. diameter rods spaced in a circle, and spirally wound with No. 6 gage wire. The posts at the intersection of the bulkheads are 10 in. by 10 in., and are reinforced with ½ in. diameter rods placed in a circle, with their ends fixed to the girders of the deck and bottom. They also are spirally wound with No. 6 gage wire. The side posts are reinforced with ¾ in. diameter and ½ in. diameter rods fastened to the deck and bottom girders by stirrups ¼ in. diameter. The gunwale girder is reinforced with 1 in. diameter and ½ in. diameter rods, with ¼ in. diameter stirrups arranged at 6 in. centers.

The concrete for the bottom and sides was composed of 4 parts ¾ in. gage blue metal shivers, 2½ parts sand, and 1½ parts Portland cement, and for the bulkheads and deck, 4 parts of ¾ in. blue metal shivers, 2½ parts sand, and 1 part cement.

A second pontoon of similar construction has the following dimensions: Length overall, 124 ft.; beam, 44 ft.; depth, 9 ft. The concrete used in the construction of the bottom and sides was composed of ¾ in. blue metal shivers 2 parts, pea gravel 2 parts, sand 2½ parts, cement 1½ parts.

A New Form of Reinforcing Metal for Concrete

From Le Genie Civil

M. Charles Rabut, a retired inspector of the French bridges and roads, has recently presented a paper to the Académie des Sciences in which he proposes a new form of reinforcement for concrete, which consists in substituting thin flat or curved plates or tubes for the bars and rods now in use.

The present use of three courses about a given point is always superfluous as three tri-orthogonal tensions can be arranged in two perpendicular planes, one of which possesses only one degree of freedom; these two planes should therefore contain the two principal tensions, one of these being the largest of the three under consideration and the two other tangential to a third virtual course, so as to form an ideal reinforcement by means of a system of triple orthogonal surfaces, especially as each of the three courses may be real in some areas and virtual in others, according to the position of the external forces.

In a structure where the three principal forces are tensile it is desirable to combine a course of bars with a plate, each point in the combination being so fixed that the bars are placed in accordance with one of the principal tensions and the plate in accordance with the two others.

The use of plates, as proposed by M. Rabut, is claimed to have the following advantages:

(1) A saving in the labor required to place a given weight of metal in position.

(2) A greater stability before and during the placing of the concrete.

(3) Use of the resistance of the internal forces in the structure in two principal directions instead of only in one as hitherto.

(4) In the case of a plate covered on both sides with concrete, the two faces are independent of the direction of the total tangential force.

(5) In the case of plates covered on only one side, the maximum resistance is obtained by the removal of the neutral axis to a maximum distance, the suppression of the dead zone (i. e., the zone of material between the reinforcement and the surface) which never possesses the same strength as the remainder of the structure, the protection of the concrete from shocks, chemical corrosion and infiltration and the use of the reinforcement as part of the form or shuttering.

(6) The possibility of increasing the adhesion by soldering or welding the bars to the plate in a transverse direction to the tangential forces and to the pressure on the concrete.

(7) The ease with which the use of concrete may be avoided in parts where metal alone will suffice, as in the case of concrete tubes, where the metal acts in accordance with its longitudinal adhesion and transverse tension.

M. Rabut's experience with concrete reinforced with tubes or plates shows:

(a) The forces acting on the tube may be calculated by the ordinary rules.

(b) There is no need to consider the resistance of the filling, as it has, naturally, sufficient resistance to compression. Hence, lean concrete or even sand may be employed.

"Tubed concrete" is specially useful for the economical construction of structures heavily loaded at the end, for the pylons of suspension bridges, aerial hangars or stations, wireless stations or large viaducts. This is quite distinct from the use of piles and tubular foundations in which the tube or column carries the load directly.

For structures with simple curves the reinforced bars may usually be replaced by a piece of thin sheet iron which is filled with concrete.

A very important application of this new reinforcement is for railway sleepers, for in all such articles there is an enormous advantage in doing away with the reinforcement of the neutral axis, inasmuch as it also obviates on the dead zone, which may be ½ in. to 2 in. thick, only a total thickness of 2½-6 in. Reinforced planks made by the new arrangement seldom need any other reinforcement other than a fixed band of metal, which also serves as a mould. The shells of boats can be designed on the new system in an equally simple manner. Curved structures under longitudinal [illegible] is retaining wall [illegible] by a plate or [illegible] angle resistance to [illegible] placed in the direc- [illegible] In the opinion of [illegible] will put an end to the dis- [illegible] at intervals in barrages built on older ideas of reinforcement.

The Alignment of Roman Roads

[illegible]

[illegible] World Like to [illegible] raises a query as to [illegible] in aligning their roads [illegible] mentioned by your contributor, in which the help of astronomical observation is suggested. I am not in a position to criticise the idea, but the [illegible] recourse to a theory of that kind. Should any of your readers feel curiosity [illegible] refer to "Roman Roads in Britain," by Thos. Codrington, M. Inst. C. E. A careful survey of hundreds of miles of Roman roads has left [illegible] that in laying out a straight line of road between two points invisible from one [illegible] from two intermediate points from which the extreme points were visible, bringing all four into line by means of smoke signals, and thus obtaining the straight alignment desired. The author points out that the straight reaches in which it was so often found convenient to set out a Roman road are commonly not absolutely straight, but, on the contrary, contain straight pieces not in true alignment, and he has observed that such pieces generally point to some natural or ancient landmark—such, for example, as a barrow. It is also to be remarked that changes in direction, when they are not influenced by the existence of towns or military stations which the road was intended to serve, almost always occur on high ground.

Mr. Codrington remarks that the straightness of the Roman roads is less remarkable than the grasp of the features of the country, which the roads appear to indicate as having been possessed by those who laid them out. The straightness is certainly a feature which has usurped a disproportionate amount of attention, since it is largely absent on numbers of Roman roads both in this country and abroad (it is strikingly absent from the Roman roads in Asia Minor—upon which St. Paul was a frequent traveler); but, personally, I am disposed to think that the value to the Roman engineers of the aboriginal traffic routes has never been sufficiently recognized. Pre-Roman Britain was not a roadless country—if by road we understand not a piece of construction but merely the beaten track indicating a custom of passing over the land along some defined line. The tracks and paths among all barbarous communities tend to establish themselves by a process of trial and error, as generations of travelers attempt to make their way across country without encountering easily avoidable obstacles, and in time there grows up a system of communications very intimately related to the physical conditions then [illegible]ng. Now there was such a system here when the Romans arrived—great lines of road following long escarpments (like the Icknield Way), or feeling their way along the water partings (like Watling-street and the Fosse Way), and the invaders, knowing well enough that native paths offered reliable guidance to the existence of practical natural routes, accepted the lines thus indicated, and, where they needed roads, laid the old tracks out anew. It is not suggested, of course, that every meandering native road would have a value, while many features which had been real obstacles to the British would cease to operate as barriers among a people who were prepared to pave fords, bridge rivers, maintain ferries, throw causeways over marshes and construct an elaborate artificial traveling surface. The old and the new roads were thus often a few miles apart in places, but the latter were none the less relocations of the former, and the debt of the Romans to the immemorial tracks is only thinly disguised. Naturally the Romans must have needed to make many arterial roads in directions in which no existing tracks ran; but there is reason to think that most, if not all, of the great trunk lines of Roman road in Britain had native predecessors.

Reginald Wellbye.

Sewage Disposal by Dilution, Including Chlorination of Sewage Effluent and Treatment of Sludge

By W. C. EASDALE

From The Surveyor, March 21, 1919

Early in 1915 the author was called upon to design the sewers and sewage disposal works for the large military camp of Caterick Camp, Richmond, Yorks. The River Swale, into which the treated effluent is discharged, runs into the River Ouse, from which the city of York obtains its water supply. At that time all military works were looked upon as being of a more or less temporary character, and although it was not possible to construct temporary sewers and sewage works, it was desirable to keep the cost as low as possible.

The site of the camp extends over three separate valleys, each drained by a brook, the three brooks ultimately discharging into a river of considerable size at some distance from the camp. The sewers are designed to be capable of taking three times the maximum hourly flow of sewage, and although a storm-water overflow is constructed on the outfall sewer near the disposal works in case of emergency, up to the present it has not come into operation. In dry weather there is very little fluctuation in the flow of sewage from hour to hour. The greater part of the sewage runs off between the hours of 7:30 a. m. and 10:30 p. m., and is practically at a uniform rate. From 10:30 p. m. to 7:30 a. m. there is a very small flow, and this also is at a uniform rate.

A very favorable site was secured for the disposal works in a field about half a mile distant. The outfall sewer reaches the tanks half way down a considerable fall in the ground at a level about 20 ft. above the lower and flatter portion of the site which is available and of ample area for filters should these become necessary in the future. In addition, there is sufficient area for considerable extensions of the tanks and other works if required.

Method of Disposal.—With the object of arriving at a decision as to the best method of disposal to adopt, the primary consideration was the reduction of expenditure, and the second was the most suitable point of discharge of the sewage effluent. The nearest watercourse is one of the brooks already mentioned, which would necessitate the production of a highly-purified effluent. By carrying the effluent about 400 yd. further, it can be discharged into a comparatively large river. The flow of this river in dry weather was found by rough gaging to be about 40 times the estimated volume of sewage, and analyses of the water showed that while it contained evidence of previous pollution by sewage, as indicated by the presence of 100 bicillus coli per c.c., it was at the same time completely saturated with dissolved oxygen.

As the current velocity was very rapid—viz., 103 ft. per minute—and it was possible to arrange the outfall in such a manner as to secure thorough mixing of the sewage effluent with the river water in a short time, it was evident that the conditions fulfilled the requirements laid down by the Royal Commission on Sewage Disposal in their eighth report, paragraphs 4 to 42, as suitable for disposal of the effluent by dilution.

The volume of sewage to be treated was given by the authorities as 15 gal. per head per day. The author allowed a margin of safety of 33 per cent and based his calculations upon 20 gal. per head per day; but even this has proved to be too low a figure, as the volume in actual operation has been about 30 gal., and, although the works have not yet had to deal with the total population provided for in the calculation, the daily volume has, on a number of occasions, exceeded the total volume for which the works were designed.

In preparing a scheme for disposal by dilution, it was considered necessary to have in view:

(a) The removal of the maximum percentage of solids in suspension;

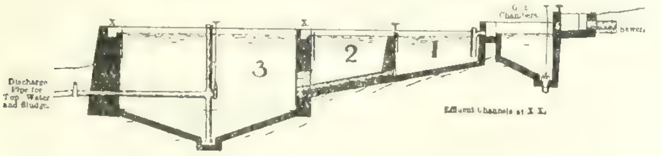
(b) The maintenance of the sewage in a fresh condition while passing through the tanks; and

(c) The treatment of the sludge in such a manner as to facilitate its disposal without causing any fouling of the tank effluent.

The attainment of these three objects involved the design of a special type of tank which has been proved in actual operation to fulfill these requirements. Owing to the excellent gradients, the sewage arrives at the works in a fresh condition, without putrefaction having been set up while in the sewers.

Screen and Grit Chambers.—Two grit chambers were provided, without screens at first. In a short time it was found that the large amount of rags, socks, shirts, caps and other foreign materials in the sewage caused so much trouble—especially in connection with the sludging operations—that it became necessary to construct a screen chamber fitted with duplicate hand-operated screens. Deposits in the screen chamber and in the grit chambers are discharged by sludge valves and pipes to a separate draining bed and are afterwards spread on the land.

Settlement Tanks.—These are four in number, each divided into three compartments. The first compartment receives the sewage after it leaves the grit chambers through four submerged inlet pipes provided with hand penstocks for regulating and shutting off the flow. The outlet is in the form of a long weir the full width of the tank, and with a baffle board in front of it. It will be noticed from the drawing that, taking the length as being in the direction of the flow, this compartment is twice as wide as it is long. In effect the sewage flow, contrary to the usual practice, takes place across the shortest dimension of the tank. This arrangement was adopted in order to obtain the greatest possible length of weir outlet and thus facilitate the deposition of the solids in suspension. As a result of 2½ years' operation, it can be stated that the bulk of the solids are actually deposited in this compartment. The deposit found in the next compartment through which the sewage flows has always been very small in quantity and consists only of very finely divided suspended matter.


X
X
3
2
1
Grit Chambers
Sewer
Discharge Pipe for Top Water and Sludge.
Effluent Channels at X X.

Longitudinal Section Through Settling Tanks.

The floor of the first compartment is constructed with a rapid fall from three sides to the center of the long dividing wall, the top of which forms the weir outlet. At this point an outlet fitted with a penstock is connected to a c.i. pipe laid on the sloping floor of the second compartment. By this means the whole contents of the first compartment, including both sludge and scum, can be discharged into the third compartment. It is found in practice that a very even distribution of the flow of the sewage through this first compartment is obtained. This is doubtless due chiefly to the use of four inlets about 5 ft. apart and to the long weir outlet, but also to the fact that the lower ends of the inlet terminating close to the sloping floor cause the sewage to impinge upon the floor and spread out over a considerable area of the tank.

The second compartment receives the already well-settled sewage from the first compartment and serves to arrest the finely-divided suspended matter still left in the liquid. The floor has an even slope in one direction from the inlet end to the bottom of the wall between the second and third compartments where large openings are left to afford free passage for the sewage between these two compartments. This arrangement was provided in case of an emergency necessitating the passage of the sewage through all three compartments, and has been utilized on occasions when the flow has been greater than originally anticipated. The usual outlet for the final effluent is from the second compartment by way of a long weir with a baffle board in front of it along the full width of the tank. In this case, as in the first compartment, the length of the weir is twice the distance through which the sewage flows.

The tank effluent flowing over this weir falls into a channel communicating with all four tanks and fitted with a sluice gate at its junction with the main channel. The sludge in the second compartment is discharged into the third compartment through the openings in the dividing wall.

It will be seen that the whole of the solids deposited in the first two compartments can be discharged by gravity and with very little labor into the third compartment, while the effluent after settlement is discharged after passing through the first two compartments alone. As the combined capacity of the first two compartments is equal to about three hours' flow of the sewage, and the deposited solids in the first are removed every week, the sewage remains fresh and does not become fouled in its passage through the tanks.

The third compartment is designed to retain the sludge for the period necessary to secure complete digestion without risk of the products of digestion affecting the character of the effluent. The bottom is in the form of an inverted cone, the greatest depth at the center being 15 ft. to the top water level. The sludge is not allowed to accumulate to a greater depth than 6 ft., and at this level an outlet is provided in the form of a horizontal cast-iron pipe connected to a vertical standpipe extending from the bottom of the cone to above the top water level and serving as a sludge discharge pipe. At the junction of the horizontal cast-iron outlet pipe with the vertical standpipe a valve is provided through which the supernatant liquid is drawn off to a pump by which it is delivered into the inlet channel to mix with the fresh sewage and be treated again.

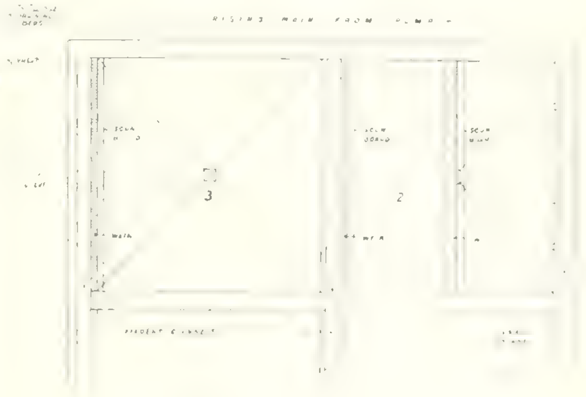
In case it should be found desirable to run the sewage through all three compartments, the third compartment is provided with an outlet weir and effluent channel similar to that provided for the second compartment.

The horizontal cast-iron sludge outlet pipes from the four sets of tanks are connected to a common discharge pipe leading to the sludge draining beds with a branch leading to a pump, for dealing with the supernatant liquid.

The capacities of the separate compartments of the tanks are as follows:

First compartment 1-20th, first and second compartments combined 1-8th, and third compartment 1-5th of the estimated daily dry-weather flow; the total capacity of the whole of the tanks is 1-3rd of the daily dry-weather flow. The size of the third compartment was determined chiefly by the sludge storage capacity.

Method of Operation.—With the normal flow the sewage enters the first compartment near the bottom, flows across the tank, up under the baffle board, and out over the long weir. It enters the second compartment at the top, flows down and across the tank, up under the baffle board, and out over the long weir into the effluent channel. Normally there is no flow of sewage through the third compartment.



Plan of One Unit of Settling Tanks.

The suspended solids deposited in the first and second compartments are discharged once per week into the third compartment in the following manner: The valves on the inlets to the first compartment are closed and the supernatant water in the second and third compartments is drawn off through the cast-iron standpipe to the pump and delivered to the other tanks in operation at the time.

When this has been done, some sewage is admitted to the first compartment (which has remained full) and as this overflows into the second compartment it washes down the sludge on the floor into the third compartment. The valve on the outlet at the bottom of the first compartment is then opened and the whole contents, including sludge and scum, is also discharged into the third compartment. The discharge of the thick sludge at the bottom is usually assisted by a man using a squeegee; but this is not really necessary, as such assistance can be rendered simply by admitting small quantites of sewage, which break up and carry through practically the whole of the sludge on the floor, and even thick blocks of scum. It will be noticed that by this means the troubles [illegible] the sludge and [illegible] of the solids [illegible] separately as [illegible]

[illegible] sludge, in the third compartment, is [illegible] the valve on the horizontal sludge pipe [illegible] being closed, the head of water in the tank forces the sludge around the [illegible] along the common sludge pipe to the sludge-draining beds.

[illegible] in connection with these tanks. Although scum forms in the first compartment, [illegible] the second and third compartments. The [illegible] of the sewage in the third compartment [illegible] foul liquid and to cause [illegible] smells. As a matter of fact, this does not happen. There is no [illegible] smell either from the [illegible] or from the supernatant liquid when it is drawn off and pumped up for further treatment. While the tanks stand full, very few bubbles of gas appear at the surface. As the head is reduced when the supernatant liquid is drawn off, gas bubbles appear in ever-increasing numbers, and when the liquid has been lowered 7 or 8 ft., the surface [illegible] bubbles. From this it may be safely inferred that the pressure due to the head of water [illegible] the top of the sludge) causes the gas to be retained in the sludge and liberated only when the sludge is discharged on to the draining beds. This probably also accounts to some extent for the comparatively rapid rate at which the sludge is dried on these beds, the escape of the gas [illegible] the sludge more open and thus allowing the moisture to drain away easily.

It should be observed here that the gas from the sludge, when it does escape, has not at any time given off the characteristic odor of sulphuretted hydrogen associated with septic tanks, and one of the most remarkable features of these works is the entire absence of any objectionable smell even when the sludge is being discharged. This has been recorded in other cases of somewhat similar methods of treatment, notably in the United States, and it has been suggested that the gas in question consists almost entirely of methane or marsh-gas. Slight local smells that have been noticed on a few occasions have been from the screenings or fresh sludge from the grit chambers, or from dried sludge which has accumulated once or twice in heaps and has commenced to putrefy.

These tanks can be worked in three different ways. In the first the sewage is passed through the first and second compartments only, flowing out by way of the effluent channel between the second and third compartments. In the second, the sewage passes through all three compartments and out by way of the effluent channel at the outer end of the third compartment. In the third method, part of the sewage flows out from the second compartment and part from the third compartment—i. e., both effluent channels are in operation simultaneously. So far as the quality of the effluent is concerned in respect to solids in suspension, there is very little difference in the results obtained by either of the three methods of operation. With regard to the question as to whether the digestion of the sludge is affected by the passing of the fresh sewage through the third compartment and whether it is more thorough when the fresh sewage passes through the first and second compartments alone, sufficient information is not yet available. Further observations over a considerable period are necessary before this point can be settled. In the author's opinion, the chief factor in the matter is the pressure due to the depth of the supernatant liquid whereby the gases formed in the sludge are retained therein and only escape when the pressure is removed by the discharge of sludge onto the sludge-draining beds.

The efficiency of these tanks in the removal of the solids in suspension is indicated in the foregoing analytical figures:

Measuring Apparatus.—The tank effluent as it leaves the two effluent channels mentioned above enters the main effluent channel in which is fixed a gaging weir with a Lea Recorder, which records the flow of sewage on 24-hour charts. This apparatus has been extremely useful not only in measuring the daily volumes, but in registering the hourly fluctuations in the rate of flow.

Chlorination of Tank Effluent.—In order to be in a position to anticipate any possible complaints as to the bacterial pollution of the river water, the author included in his scheme means for adding sufficient chlorine solution to destroy all bacillus coli in the tank effluent. The whole of the apparatus used in this part of the scheme was supplied by the Candy Filter Co., Ltd., and consists of a special mixer for converting the chloride of lime (bleaching powder) into a liquid solution, an air cylinder and pump for raising the solution into two concrete settling tanks built at a higher level, a water wheel operated by the treated sewage for working the pump and mixer, and a special automatic control for regulating the quantity of the chlorine solution discharged into the settled sewage. The automatic control is in the form of a miniature weir, which is connected to a float controlled by the weir used in connection with the Lea Recorder, so that the depth of chlorine solution flowing over the miniature weir is always in exact proportion to the sewage flowing over the large weir. In this way correct automatic regulation of the quantity of chlorine added to the sewage is ensured according to the variation of the flow of sewage.

Thorough mixing of the solution with the effluent is secured by means of a series of slate baffle plates fixed in the effluent channel, and the effluent then passes through two tanks, which have a total capacity equal to half an hour's flow of the sewage, in order to give the period of contact required for the chlorine solution to act upon the bacteria.

After the works had been in operation for some time it was found that, in spite of the settlement of the crude chloride of lime solution in the two tanks provided for the purpose and used alternately, a considerable amount of lime was deposited in the pipes leading to the regulating apparatus. To overcome this trouble, further settlement has since been provided in the form of an additional settling tank, which now receives the crude solution; the clear liquid from this tank flows by gravity into the original settling tanks, where further settlement takes place and a much clearer solution is thus produced.

In a scheme of water supply recently carried out by the author, the above-mentioned trouble in connection with the use of chloride of lime has been avoided by the use of an electrolytic chlorine solution. The raw material in this case is common salt, which is dissolved in water to a given strength. This brine then flows at a fixed rate through an electrolyser fitted with a series of electrodes to which the electric current is connected. The passage of the electric current through the brine decomposes it, liberating chlorine and sodium, as well as hydrogen and oxygen. The oxygen and chlorine then combine and form hypochlorite of sodium, which possesses exceptionally powerful germicidal qualities. The solution contains from 0.2 to 0.3 per cent of free available chlorine. It is perfectly clear, does not cause a deposit in the pipes, and is of definite strength.

By means of the arrangements provided in the settling tanks, it is possible to draw off only thoroughly digested sludge. This is discharged by gravitation to four sludge draining beds. These beds are simple excavations in the ground and are provided with ample under-drainage in the form of rows of 2-in. agricultural pipes connected to a 4-in. main sub-drain, which conveys the drainings to a sump under the pump-house. The pump used to deal with the supernatant water from the settling tanks, has a branch on its suction pipe taken into the sump, and by this means the drainings from the sludge are pumped up to the sewage inlet channel for further treatment with the fresh sewage.

The draining beds are formed of a bottom layer of coarse

ANALYSES OF CRUDE SEWAGE AFTER PASSING THROUGH [illegible] AND TANK EFFLUENT AFTER CHLORINATION.

	Suspended solids.			Chlorine.		Oxygen consumed in 5 minutes.			
[illegible]	[illegible]	[illegible]	Per cent removal.	Crude sewage.	Tank effluent.	Crude sewage.	Tank effluent.	Per cent purification.	Chlorine added. Parts per million.
	Parts per 100,000								
[illegible]	39.0	22.5	42	11.6	....	4.3	[illegible]	[illegible]	4.4
Oct. 25	[illegible]	[illegible]	[illegible]	11.6	....	3.7	[illegible]	[illegible]	4.3
[illegible]	[illegible]	[illegible]	[illegible]	11.6	....	3.4	2.4	30	4.3
Average daily volume of sewage, [illegible] gal.									
1918.									
June 17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	48	9.05
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.8	41	9.52
June 21	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.4	30	9.20

Average daily volume of sewage, 778,666 gal.

gravel, upon which rests a layer of fine gravel, which supports a top layer of coarse sand, the whole being only 18 in. deep. The sludge is delivered on the beds from a concrete channel constructed along the center of the beds with openings controlled by hand sluices on both sides. As the sludge is delivered in a fairly liquid state, it distributes itself evenly over the surface. In normal weather the sludge is dried to a spadeable condition in about eight days. A representative sample of the sludge taken from one of the beds at this stage was examined for the author by Dr. S. Rideal, and it was found to contain 72 per cent moisture and 0.9 per cent nitrogen, which is equal to 2.8 per cent on dry sludge containing 10 per cent moisture.

For some time at first the dried sludge accumulated in a heap at the works. Later, arrangements were made with the farmer whose fields adjoin the works to use the sludge for his land. By the spring of 1918 the original accumulation of sludge had all been removed, and since that time the whole of the dried sludge has been taken away by the farmer as produced, so that the only sludge on the works is that which is being dried on the draining beds.

The good effect of the sludge was apparent in the early summer from the excellent appearance of the crops to which it had been applied. According to a report from the farmer, the continued wet weather during the latter part of the summer spoilt the crops of wheat, barley and oats, and considerably reduced the yield. In spite of this, the result was about twice as good as in previous years on the same farm, and much better than on neighboring farms where the sludge was not used. The best results were obtained when the sludge was plowed in during the autumn, and it is recommended that the sludge should be accumulated in convenient heaps during the other three seasons, and not spread on the land until the autumn. It was anticipated that the use of the sludge would produce a large crop of weeds, but very little of such vegetation has appeared. There is no evidence to show whether this was due to the absence of seeds in the sewage or to some effect upon them of the action which takes place during the digestion of the sludge in the tanks.

Effluent Outfall.—The tank effluent after it leaves the tanks, provided to ensure sufficient contact of the chlorine solution with the sewage, flows down a series of aerating slopes into the effluent pipe, which conveys it for a distance of about 500 yd. direct to the river. At the outfall the top of the river bank is about 8 ft. above the summer water level. At this point the effluent drain terminates in a manhole, from which a cast-iron pipe is laid about 3 ft. deep in the bank, from which it emerges at about summer water level and then continues on the sloping bed of the river for a distance of about 15 ft., terminating with two outlets in the deepest part of the stream at the bottom of the river. There is always a considerable volume of water with a high current velocity at this point, so that the effluent becomes thoroughly mixed with the water in a short distance.

Effect of Sewage Effluent Upon the River Water.—Dealing first with the physical effects, it can be stated that at no time has it been possible to detect any objectionable odors from the water or any deposits of organic matter either in the bed or on the banks of the river.

The chemical and bacteriological effects are shown in the results of the analyses and examinations which are set out herewith in tabular form.

It will be noticed that in all cases the river water above the outfall—i. e., before receiving the sewage effluent—is fully saturated with dissolved oxygen. At the same time it also contains evidence of previous pollution in the presence of bacillus coli. It is unfortunate that it has not been possible to make analyses when the dilution was somewhere near the 40 to 1 ratio, which was taken as the basis of calculations when the scheme was prepared. The volume of water in the river varies considerably from time to time.

CHEMICAL ANALYSES AND BACTERIOLOGICAL EXAMINATION OF RIVER WATER

"A" = above outfall; "B" = about 300 yd. below outfall; "C" = about 1½ miles below outfall.

Sample taken. 1917	Chlorine "A"	Chlorine "B"	Chlorine "C"	Dissolved oxygen "A"	Dissolved oxygen "B"	Dissolved oxygen "C"	Bacillus coli "A"	Bacillus coli "B"	Bacillus coli "C"	Ratio of dilution Water to sewage	Chlorine added Parts per million
	Parts per 100,000						Present in cc.				
Oct. 23	[illegible]	1.2	[illegible]	[illegible]	[illegible]	[illegible]	0.01	0.01		137 to 1	4.4
Oct. 25							0.001	0.01		142 to 1	[illegible]
Oct. 27							0.01	0.01		180 to 1	4.9
Nov. 7									0.01	......	
1918.											
June 18	1.45	1.5	1.5	1.1	0.52	1.02	0.01	0.001	0.01	18.4 to 1	[illegible]
June 19	1.45	1.5	1.5	1.1	0.59	1.03	0.01	0.001	0.01	18.7 to 1	9.52
June 21	1.40	1.8	1.7	[illegible]	0.59	1.02	0.1	0.001	0.01	19.1 to 1	9.20

With a good volume of water, as in October, 1917, the discharge of the sewage effluent causes practically no alteration in the character of the river water. Even during extremely low water, as in June, 1918, when the dilution was only 18 to 1, the dissolved oxygen was not reduced below 50 per cent saturation, so that there was no injury to fish life. Moreover, at a point 1½ miles below the outfall the water had recovered its oxygen and was again fully saturated. This means that under these conditions 731 lb. of the dissolved oxygen in the river was used up every 24 hours in oxydizing the organic matter brought in by the sewage effluent. On the other hand, during its flow for the next 1¼ miles, 708 lb. of oxygen was extracted from the air in the process of natural re-oxygenation to make good the previous loss. This is an excellent concrete example of the process of self-purification in rivers.

With regard to the bacteriological aspect, it is clear from the results of the examination of the first three samples that although the chlorine added to the sewage effluent was only an average of 4.5 parts per million, and the destruction of the bacillus coli could not have been complete, the discharge of the sewage did not cause an increase of these organisms in the river water when the ratio of dilution was high. On the other hand, in the case of the last three samples, the addition of even nine parts per million of available chlorine to the effluent did not destroy all the bacillus coli, as a considerable increase of these organisms in the river water was found 300 yds. below the outfall. As in the case of the dissolved oxygen, this increase had disappeared at a point 1½ miles below the outfall, where the condition of the river water was exactly the same as above the outfall. As to the cause of this recovery from the bacteriological point of view, the author has no suggestion to make, but hopes that it will be explained by the bacteriologists. As the services of the author were retained by the War Office to inspect and report upon these works at intervals after they were completed, and this arrangement still continues, it is hoped that further evidence will be obtained in due course as to the quantity of chlorine necessary to destroy all the coli organisms in the effluent.

On the whole, it is evident that the ratio of dilution—viz., 40 to 1—suggested by the Royal Commission on Sewage Disposal in Table B, page 11, of the eighth report, for an average septic tank liquor discharged into a rapid river fully saturated with dissolved oxygen is a safe basis to adopt. That, in the present case, the dissolved oxygen was not reduced below 50 per cent saturation, even with so low a dilution as 18 to 1, was probably due to the sewage being fresh and not septic.

General Conclusions.—Having described the scheme in detail, the author desires to state that, although the working of the tanks may at first sight appear to be somewhat complicated, it is not so when once they are brought into regular operation. At the outset the author prepared a detailed set of instructions, and these have proved to require very little modification after 2½ years' operation. At the same time, everything depends upon careful and intelligent management, and much of the success obtained has been due to the unremitting attention and capable handling of the present manager.

While this system of disposal is not suitable for general application, there is no doubt that it should be satisfactory where the conditions are similar, especially in respect to the volume and character of the river water and the condition of the sewage when it reaches the works. The method of dealing with the sludge may, however, be adopted in almost any other case. In the matter of economy it is obvious that the omission of filters, humus tanks and other works, which would be necessary to produce a highly-purified effluent, must effect a considerable saving. In the present case it amounted to between £15,000 and £20,000.

A New Way of Coloring Glass.—A French scientist has invented a process for applying colors to glass by heat so that stained glass windows can be made without fastening many pieces of glass of different hues together.

Unit System for Reinforced Concrete Building Construction

[illegible]

A new [illegible] in reinforced concrete construction, [illegible] has recently been invented and patented by [illegible] of the firm of [illegible] Heath [illegible] and building engineers, Manchester, [illegible] The advantages claimed for the system are: (a) [illegible] so far as building construction [illegible]; (b) all parts are cast in moulds, which may be used over and over again, thus saving timber [illegible] being practically [illegible] when compared with normal methods—and effecting great [illegible]; (c) the operations take place [illegible] the work is more easily accessible, a further saving of time and labor results; (d) all reinforcements are assembled before being placed in the moulds in such manner that a glance is sufficient to indicate whether or not the various bars have been placed correctly; moreover, the bars cannot become displaced while ramming; (e) the moulding may be done under cover and may be carried on in all weathers with a considerable saving in time; (f) erection, when once started, can proceed without intermission, which results in a further saving of time; and (g) the structure when erected is at once "weight bearing," because before being lifted the various parts or units have become thoroughly matured. It will be gathered from the following description that rods are introduced over all bearings, with the object of ensuring that the structure shall possess full monolithic properties, and of preventing cracks.

Fig. 1—Heathcote System of Concrete Construction.

The accompanying drawing, Fig. 1, will serve to explain the principles of the new system. The column foundations are formed of plain concrete, and only in cases of excessive loads, or for other reasons, is it necessary to introduce reinforcements. In the top of the foundation a socket or depression is formed by means of casting into the concrete, a "print" made of timber or other suitable material, which can be withdrawn when the concrete has sufficiently set. Into these sockets the lower ends of the first tier of columns are inserted, the sockets being made slightly larger than the columns to allow of a little adjustment for properly spacing the columns to exact centers, and for afterwards grouting in.

The columns are preferably octagonal in section—see Fig. 1—this being the most suitable shape for this system of construction. The method of reinforcing is the same as for any ordinary octagonal column. Facilities for lifting are provided by casting "eyes" into the column head, which special provision precludes the possibility of damage from ropes or chains, which would otherwise take place in lifting. The spreading octagonal column heads provide seating space or bearing for the ends of beams, and sockets or depressions are formed in them to take the lower ends of the columns for the next story.

The normal section of the main beams is, roughly speaking, rectangular, but the ends are moulded to special shape to suit the octagonal heads of columns, as shown in Fig. 1. At points in the length of the beams, pockets, in which may sit the ends of intermediate secondary beams, are formed as required. In the top of the beams a groove is formed in which, over the bearings, rods are inserted, these rods being intended to tie the whole construction together, and to secure for it those monolithic properties aimed at, as well as to prevent cracks. The beams are reinforced both at the top and bottom in such a manner that all stresses to which the member may be subjected during transit are properly provided for.

Like the main beams, the secondary beams are, roughly speaking, rectangular in section, and, in the case of the intermediate beams, of uniform shape throughout. Where they rest on columns, however, the ends are of exactly the same shape as the ends of the main beams, to suit the octagonal heads of the columns. The reinforcements and the facilities for lifting are generally the same as for the main beams.

The floor and roof slabs are made in convenient sizes for handling and erection. The ends of slabs rest on the secondary beams, and the sides butt closely together. To prevent any single slab, or a number of slabs, deflecting unduly, leaving the others standing, grooves are formed in the sides of the slabs, which, when filled with grout form what is claimed to be an effective key between one slab and another. The edges of the slabs are rebated so that when two slabs are lying together, a groove is formed into which rods are introduced over the bearings, for the same purpose as described above in connection with the beams. The slabs are reinforced in such a manner that, apart from the normal loading, stresses which may arise in handling and transit are properly provided for. Lifting eyes are provided to give every facility for handling and erection.

In erecting the structure the concrete foundations are, first of all, properly and accurately leveled up, after which the first story columns are placed in position and propped. When it has been decided that the columns are accurately spaced and plumb, or at any other convenient time, the bases are run in with cement grout. The main and secondary beams for the floor above are then lifted and placed in position, the ends being bedded in cement, and the joints between the ends of the beams pointed up in cement. The floor slabs are then lifted and placed in position, their ends being bedded in cement, and the joint between the edges of slabs pointed up with cement on the underside. The next operation is to lift, place in position, and prop the second story columns, correct spacing and plumbing being carefully performed. The next stage of the work is entirely governed by the type of floor finish which is to be used. If the finish is to be of boards, wood blocks, or anything of a similar nature, the method of procedure is as follows: Rods are laid over the bearings of the main beams, secondary beams and slabs, in the grooves provided for the purpose, and cement grout or fine concrete is poured in up to the level of the top of the floor slabs. This additional concrete or grout, in conjunction with the rods now embedded in it has, the inventors maintain, the effect of tying the various parts or units one to another, so that a perfectly monolithic piece of construction results. In the event, however, of the floor finish being of granite and cement the following method of procedure is adopted: Rods are laid over the bearings of the main and secondary beams, and grout or fine concrete as required is poured only up to the level of the bottom of the grooves in the slabs. The slag rods are not laid until all is ready for putting on the floor finish, when they are placed in position and embedded in the floor finish itself, which fills up the slab grooves, and in this manner provided with a key. The foregoing procedure is followed for each of the remaining floors, and also generally for the roof.

Cause of Mud Formation on French Roads.—In a paper presented last December at a meeting of the Institution of Civil Engineers, Mr. Thomas B. Bower disputed the commonly accepted view that the excessive amount of mud on the roads of France is due to the metal being forced down to the chalk or other subsoil, which then comes to the surface as mud. Excepting in the case of paved roads, and roads badly worn in holes, he is of opinion that no mud rises to the surface by pressure from above. The true cause of mud formation is the poor quality of the material used—viz., limestone of very soft and porous nature, which, by attrition through some inches of depth, forms the mud, while destroying the surface. The only other materials available in France for the military roads were pit-props, whole or split, brick rubble, and a poor quality of flint gravel.

The Francois and Portier Grouting Processes

By A. H. KRYNAUW.

From Transactions Chemical, Metallurgical and Mining Society.

During recent years experience has proved that cement can be introduced, under pressure, into the minutest fissures and cracks in rock strata, as well as cracks and interstices in masonry and concrete constructions, and made to set there. This practice of introducing cement grout under pressure has evolved to that known today as the Francois cementation process.

An essential condition in the introduction of cement into fissures and cracks is that the injection should be done under a considerable pressure, the object being, firstly, to overcome the contra pressure of water present in the fissure; secondly, for the purpose of forcing the cement as far as possible into the minute cracks; and, thirdly, for the purpose of squeezing out the superfluous water from the cavity which is being filled with cement pulp, and thus leave the cement in a condition most suitable for its rapid and efficient setting.

Cement milk, when allowed to set ordinarily under water, does so only very slowly and reluctantly, but when the same milk is subjected to pressure, such as produced by a specially constructed cementation pump, the cement sets hard within 24 hours. The setting of cement is chiefly due to the inter-crystallization of hydrated calcic silicate and hydrated calcic aluminate, just the necessary amount of water being taken up to complete the crystallization; the crystals grow together and form a hard mass. Now, when a superabundance of water is present, such as in the mixture used in cementation work, these crystals ordinarily seem reluctant to inter-crystallize; consequently, the setting of the cement is very slow and incomplete.

The condition most suitable for hard setting in the shortest time, when the cement is pumped under pressure into fissures, etc., appears to be somewhat as follows: First of all, the constructed exits of the fissures are choked with cement pulp, which forms a filter bed on which successive layers of cement are deposited, the surplus water being squeezed out through the cement filter already formed in the peripheral areas of the fissure or cavity. As more cement solution is injected the pressure gradually rises and goes on rising, owing to the fact of the water having to be squeezed through an increasing thickness of cement filter. The successive layers of cement eventually fill the fissure or cavity completely, leaving the cement in a condition suitable for complete and good setting. Pressures of 1,000 to 4,000 lb. per square inch are used, and for this purpose a specially designed pump is employed, of the double ram horizontal type with a 12-in. stroke, the steam end having a diameter of 14 in. and the water end plunger diameter of 1⅝ to 3 in., depending on the final pressure likely to be required. As the wear on the valves is great, hardened steel balls are used.

In the following cases cementation has been successfully applied:

In greatly minimizing water difficulties in shaft sinking or tunneling through water-bearing strata, faults and dikes.

In sealing and rendering water-tight the concrete tubbing or lining often used in circular shafts.

In sealing open fissures through which water is flowing.

In damming back water leaking through broken ground, in the vicinity of faults and dikes.

In rendering underground dams water-tight.

In rectifying defective boreholes.

In rendering impervious the foundations of surface dams or making solid the rock and concrete foundations of engines, etc.

The process as applied to shaft sinking consists of a treatment of the strata, through which the shaft is to be sunk, with cement grout, which is injected into the fissures and cracks of the rock mass, thus sealing them and rendering the ground practically free of water. The method of carrying out the work is as follows: A system of drill holes is put down on the periphery of the shaft, and through these holes a thin cement mixture is introduced, which finds its way into the cracks and crevices, rendering them impervious to water.

There are two methods of carrying this out. In the Portier method the holes are put outside the perimeter of the shaft, and it is claimed that this has the advantage of permitting the sinking of the shaft simultaneously with the injection of the cement. This is a very strong point, in that it practically overcomes the interruption and delay to the sinking of the shaft while conducting the process. On the other hand, the Portier system is attended by the following disadvantages:

The possible deflection of the boreholes into the shaft, rendering them useless for the subsequent injection of cement.

The danger to sinkers, when applying great pressure in the boreholes, owing to the possibility of rupturing the sides of the shaft.

The boreholes may intercept several fissures, but the mouth of the hole being above the water level, it is not possible to tell which fissure is the chief water carrier, so that when injection takes place the tendency will be for the cement to take the course of least resistance into the larger fissures, while the smaller ones, though probably of considerable importance, are only sealed in the vicinity of the hole itself.

In the Francois system the boreholes through which the cement is introduced are put down, within the limit of the shaft, arranged on the perimeter at various distances apart, depending on the size of the shaft and thickness of rock strata to be treated. The detailed method of procedure is indicated by the following description of the work done at the Daggafontein and Brakpan mines:

Daggafontein No. 2 shaft is a 7-compartment rectangular shaft, 49 ft. long by 9 ft. wide, and was sunk from the surface to 175 ft. in dwyka conglomerate containing numerous cavities and fissures, giving a fair amount of water, but not of such quantity as to seriously hinder sinking. At a depth of 354 ft. the syenite dike of the far East Rand was encountered, and the shaft sunk in it to its present depth of 500 ft. At this stage the water dealt with amounted to 21,000 gal. per hour, and the management decided to put down a pilot borehole to ascertain the nature of the strata ahead. This hole intercepted the dolomite series at a depth of 12 ft. below the shaft bottom, and at a depth of 165 ft. a considerable amount of water was encountered.

In view of the probability of large quantities of water being met with in the dolomites, shaft sinking was stopped, and the adoption of the Francois cementation process decided upon. From the data available the thickness of the dolomite formation was estimated at 200 ft., the direction of the boreholes being set out accordingly, so as to permit of a single stage treatment for the full width of the strata. Unfortunately, the thickness of the dolomites proved to be considerably more than anticipated, being a total of 345 ft., which distance was considered too much for treatment in one stage. A distinct open parting exists at the contact of the syenite dike and underlying dolomite. This was clearly demonstrated, for when drilling through the dolomite contact the feed water was forced out of holes previously drilled. At a depth of 35 ft. the first feeder was met with containing sufficient water to cause a flow of 250 gal. per hour out of a 1½-in. drill hole. A second and larger fissure was struck at a depth of about 130 ft., and as each hole intercepted water, cement grout was injected, the progress of the inspection being observed by the rise in pressure indicated on a pressure gauge. When a pressure of 2,000 lb. per square inch was reached, pumping was stopped and the cement allowed to set. In all 55 tons of cement were used, and as the depth of the holes is about 180 ft., sinking can now be continued for that depth.

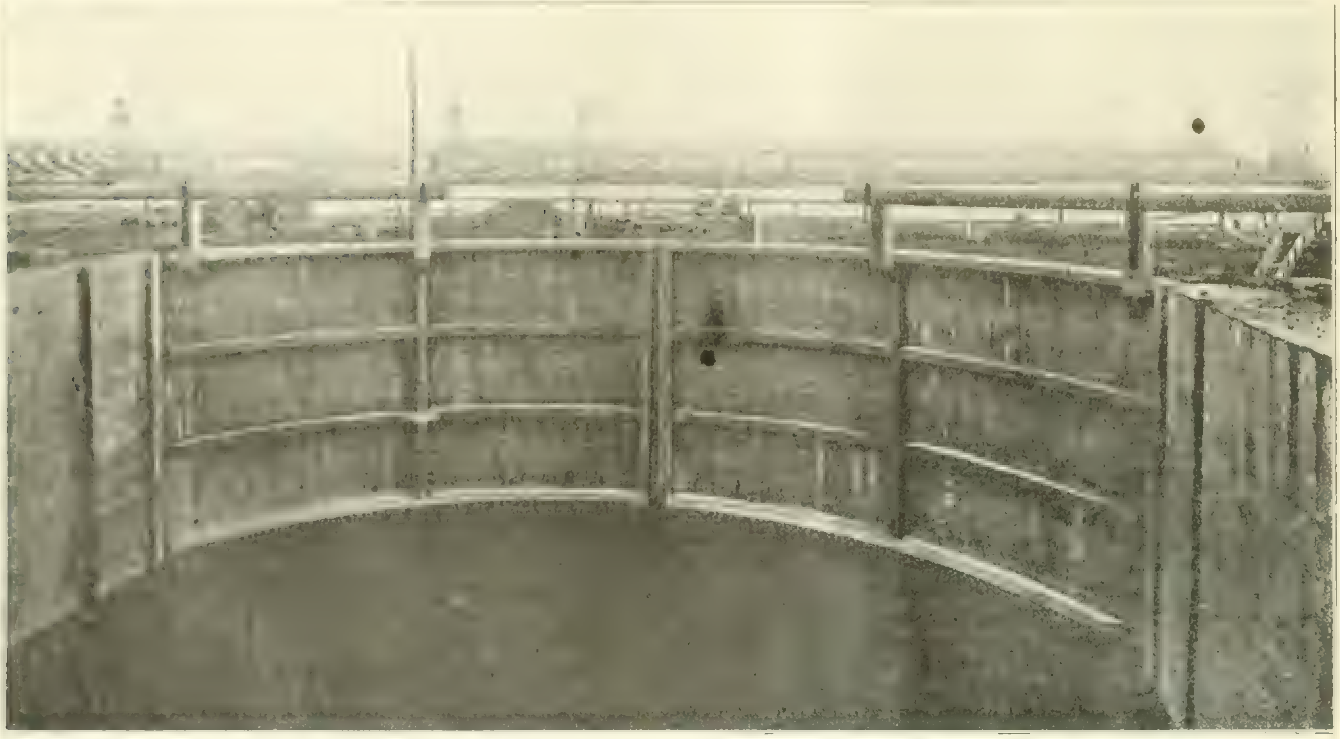
Novel Dry-Dock Construction in Sweden.—The large Swedish concern Ljusne-Voxna, which is going to acquire its own tonnage, is constructing a dry-dock, both for its own and other vessels, on a novel principle. The dock, which is to be located at Ljusne, North Sweden, will be 328 ft. in length and of considerable breadth; it will be able to accommodate vessels of 4,000 tons deadweight. The dock has been designed by Chief Engineer M. Von Eckermann and will be built on land above water-level. The vessels from the harbor will enter a lock and will then be raised and lifted into the dock by means of water from the waterpower canal of the Ljusne face. By this arrangement the dock can be filled and emptied without any pumping plant, and in consequence the cost of docking will be low.—Engineering.

Reinforced Concrete Dock Gates

[illegible]

[illegible] [illegible] [illegible] [illegible] [illegible] timber and steel [illegible] [illegible] to obtain, it was decided to introduce reinforced concrete for the purpose of constructing a system of dock gates connecting the private dock yard of Christiani & Nelson at Tilbury Dock with the Port of London Authority's main dock at [illegible] [illegible].

The dry dock was built for the purpose of constructing [illegible] reinforced concrete lighters for the Admiralty, and was completed together with the five vessels within a year. The vessels having a beam of 35 ft. the canal connecting the dry dock with the Tilbury main dock was constructed with a minimum width of 40 ft. to afford sufficient clearance for the vessels being floated through the canal into the main dock, and the free span of the dock gate in question is therefore 40 ft., the depth of the gates being 14 ft. The gates are constructed as stress line for uniform water pressure, and are therefore circular in shape, and although they have to stand a water pressure of 14 ft., the thickness of the circular slab forming the gates is only 3½ in., which, however, has proved quite sufficient in actual practice. No waterproofing compound of any description was used for the concrete forming the gates, nor was surface treatment of any kind resorted to. The gates, however, are stated to be perfectly watertight.



Reinforced Concrete Dock Gates at Tilbury.

The gates are formed as ordinary doors on top and bottom hinges, and the ease with which they are moved is indicated by the fact that two men can easily open and close them. Special precautions had to be taken in the construction of the hinges, so as to allow the gates to take up their proper stress-line position, and it was found that floating hinges at the top and at the bottom combined with an elastic medium for closing up against the bottom sill proved an efficient and successful way out of the difficulty. The water is let into the dry dock by means of two sluices operated in the usual way.

The abutments which have to take the total thrust from the arch action of the circular gates had to be founded on 50 ft. long reinforced concrete piles, in order to provide a sufficiently rigid and immovable support, as the soil on the site was totally unsuitable for taking the pressure met with.

The work was designed and executed by Christiani & Nelson, of 25, Victoria Street, Westminster, S.W., who have applied for a patent for the system of dock gate construction involved.

The 10,000 H. P. Hydro Electric Plant at Bombay

By ROBERT BATSON JOYNER.

From a paper presented Nov. 19, 1918, before the Institution of Civil Engineers.

The works described take advantage of the remarkable circumstances of the very heavy rainfall on the precipitous edge of the Western Ghats, about 2,000 ft. above, and about 40 miles from Bombay. As the rain falls only during three or four months of the year, and the watercourses are dry all the rest of the year, it was necessary to store water sufficient to give about 100,000 h.p. for 10 hours or 12 hours a day during about nine months of the year.

The lakes are formed by four masonry dams ranging from nearly ¾ mile long and 34½ ft. high to nearly 1½ miles long and 96 ft. high. Two of these form a "Monsoon" lake of sufficient capacity to provide power during the longest "breaks" in the monsoon, and thus give an uninterrupted supply of power for three months and more. The other lakes are for storage, and maintain the power during the eight or nine months in the year when no rain falls.

The monsoon rain on the Western Ghats, though always heavy, is very valuable in amount. The least annual amount during the last 48 years was 82 in. on the edge of the Deccan plain, and the greatest amount during the past 11 years, in which special gauges have been fixed, on hill-tops as well as in plains, is 546 in., which fell in a little over three months, 460 in. falling in about two months. The minimum fall of 82 in. is very exceptional, and the maximum given may be equally so. The combined available capacities of the two storage lakes is about 10,100,000,000 cu. ft., whilst the water required to give 100,000 h.p. ex turbines for nine months, allowing for the great loss by evaporation and by soakage, and for friction in the pipes and turbines, is 6,700,000,000 cu. ft. The excess capacity is given owing to the very variable amounts of the monsoon rains, so as to carry on the balances in years of excessive rainfall to make up for the occasional short monsoons. It was arrived at by assuming the works had been completed 40 years ago, there being one rain gauge record covering that period—which includes four minimum years' fall—and deducting from each year's supply the amount which would have been used, lost by evaporation, run to waste, or carried on to the next year, which gives the excess capacity required for a sufficient number of years.

The amount of 546 in. measured at one hill station in the lakes catchment is not more than has been measured in two or three years out of the past 50 odd years at Cherrapunji, in the Assam Hills, which has the heaviest rainfall hitherto known, but there rain falls during seven months of the year, so that the amount measured for this work, for that particular year, may claim to be the heaviest rainfall ever yet measured.

The works are notable for the following reasons: They are the largest of the many similar hydro-electric works which have been constructed during the past 10 or 20 years, taking into consideration the great head used, combined with the large discharge of water. They are also the first works to store water for power for use during about three-fourths of the year. One of the masonry dams, taking the exposed face area, is probably the largest yet constructed. The works are probably unique, considering the very heavy rainfall and the very steep rocky slopes, giving the greatest discharge perhaps ever recorded. The catchment area of the two lakes is only 16½ sq. miles, while of this the full lakes area is about 7½ sq. miles.

The water is led from the monsoon lake and from the two storage lakes, which are joined together by a tunnel a mile long, by two ducts, together 4.63 miles long, to the forebay at the top of the great precipitous scarf which forms the western boundary of the Deccan plateau. From there the two lines of steel pipes are taken down the steep slopes and precipices to the power-house, about 1,750ft. below the forebay, the length of single line being about 2.33 miles. The pipes at the top are 82½ in. in internal diameter, and at about two-thirds of the total height down, the diameter is 72 in. Here they are joined by a double swan-neck pipe from which eight smaller pipes are led down to the power-house, their diameter being 3½ ft. at the top, and 3 ft. 2 in. at the bottom. The thickness of the metal at the top of the large pipes is ⅜ in., and at the bottom of the small pipes 1¼ in.

Each of the lower smaller eight pipes supplies a Pelton-wheel turbine, designed to give a maximum of 13,500 h.p. with automatic regulation devices.

The New Spirit Among Municipal Surveyors

From The Surveyor, Jan. 10, 1919

There are signs that the spirit, if not the organized practice of unity is beginning to assert itself in the ranks of municipal surveyors. Instances have occurred in which army men who have been invited to take up their old appointments at the former salaries or an insufficient advance upon them have declined to do so unless they are assured of more satisfactory conditions of service. In some cases they have claimed a higher salary as an irreducible minimum, and upon this being declined, they have intimated their intention of seeking an appointment elsewhere. An instance of how this improved spirit is beginning to make itself felt occurred recently at Aldershot upon the appointment of a deputy surveyor. The surveyor, Mr. J. Neave, reported to the urban council that he had received several applications for the post, but, with the exception of one, the candidates either required £200 per annum, or were unsuitable. The particular candidate alluded to was eventually appointed at a salary of £150 rising to £200, Mr. Neave stating that he was eminently fitted for the position. The hard experience of war and the aggravated conditions of its aftermath as exampled in the enhanced cost of living have obviously combined to infuse into the minds of members of the profession a feeling of determination to insist upon a higher standard of service than has hitherto obtained, and once the ball has been set rolling, as it appears to have been, it cannot be long before local authorities will be forced to make concessions to their professional assistants which they have hitherto withheld with an obstinacy that has been worthy of a better cause. The service rendered by the operations of the institutions in creating this new spirit of camaraderie has not been without its effect, and this fact of itself is a sufficient testimony to the value of their work, as well as to the urgency of disseminating among municipal surveyors the necessity for maintaining a higher level of combination and unity than has existed in the past.

Economic Size of Concrete Ships

By E. O. WILLIAMS

From Engineering, Feb. 14, 1919

It is often stated that the disadvantage of weight of concrete ships compared with steel ships diminishes with increased size of vessels, and it is possible that the construction of vessels of very large deadweight capacity might be favored on that assumption. It was with a view of testing this statement that this study of the economic size of concrete ships was undertaken, and to suggest, if necessary, a limit to size.

It is obvious that for very small concrete vessels the thickness and sizes of concrete members are determined by practical considerations, and are greater than required to withstand stresses. Generally speaking it is not practical to construct reinforced concrete walls less than 2 in. to 2½ in. thick, and no matter how small the vessel, the slabs and beams should not be less than this dimension. The same consideration affects the design of small steel ships, but not to the same extent, and therefore small concrete ships of about 250 tons deadweight compare more unfavorably in weight with steel ships than if of a deadweight of about 1,000 tons.

Does the improvement in weight of concrete ships continue with still further increase in size? If not, at what deadweight capacity does the improvement cease? The saving of steel in a concrete vessel is greater for small than for larger vessels, for as steel ships increase in size the steel is used more economically. It can be shown from the theory of the design of concrete ships that the total tonnage of steel reinforcement varies as $\sqrt[3]{\ }^{4}$ where D is the load displacement. In the determination of this formula it is assumed that the steel stresses remain constant for all sizes of ships, and up to the size of ships considered, this would hold good. It is thus clear that the tonnage of steel reinforcement increases at a greater rate than the load displacement.

In determining the necessary amount of concrete required to embed the steel bars, there must be a maximum limit to the ratio of steel to concrete. It is assumed in the following that the maximum limit is fixed only by the practical impossibility of pouring in the concrete satisfactorily if more than a certain maximum percentage of steel to concrete be employed in any part of a wall or slab and also that when that percentage is reached the concrete is of such a high quality as to transmit stresses satisfactorily on to the reinforcement. It is clear, therefore, that when the maximum practical percentage of steel reinforcement is reached the ratio of concrete to steel will become approximately constant

A. COMPARISON BETWEEN DEAD WEIGHT AND DISPLACEMENT OF CONCRETE SHIPS.

	Vessel 1C. Tons	Vessel 2C. Tons	Vessel 3C. Tons	Vessel 4C. Tons	Vessel 5C. Tons
1. Load displacement	1,630	2,500	4,150	10,000	15,000
2. Reinforcing steel	85	150	290	900	1,5[illegible]0
3. Concrete	[illegible]	570	960	2,500	4,200
4. Fittings and outfit	90	135	200	350	[illegible]
5. Machinery	130	155	200	425	[illegible]
6. Light weight	705	1,010	1,650	4,175	6,850
7. Dead weight concrete ship	925	1,490	[illegible]	5,825	8,1[illegible]0
8. Dead weight tons of steel ship of same displacement and indicated horsepower	1,020	1,6[illegible]0	2,[illegible]80	[illegible]060	10,72[illegible]

B. STEEL SHIPS OF SAME DEAD WEIGHT CAPACITIES AS THE ABOVE STATED CONCRETE SHIPS.

	Vessel 1S. Tons	Vessel 2S. Tons	Vessel 3S. Tons	Vessel 4S. Tons	Vessel 5S. Tons
1. Load displacement	1,195	2,350	[illegible]78[illegible]	8,375	11,1[illegible]0
2. Steel in hull	385	585	900	1,860	2,4[illegible]
3. Fittings and outfit	80	125	190	2[illegible]	[illegible]80
4. Machinery	105	110	190	[illegible]	[illegible]
5. Light weight	570	8[illegible]	1,280	2,[illegible]50	[illegible]
6. Dead weight	925	[illegible]90	2,500	[illegible]	8,1[illegible]

C. COMPARISON BETWEEN STEEL SHIPS AND CONCRETE SHIPS OF SAME DEAD WEIGHT CAPACITY

1. Dead weight capacities, tons	925	1,490	2,500	5,825	8,1[illegible]
2. I.H.P. of concrete ship divided by I.H.P. steel ship	1.1[illegible]	[illegible]	1.06	1.1	[illegible]
3. Tons of steel reinforcement divided by tons of steel in steel hull	0.22	0.26	[illegible]	0.48	0.62
4. Displacement of concrete ship divided by displacement of steel ship	1.[illegible]	1.[illegible]	1.10	1.[illegible]	[illegible]
5. Constant speed I.H.P. concrete ship, friction as [illegible]	180	[illegible]	400	[illegible]	[illegible]
6. I.H.P. steel ship	150	[illegible]	[illegible]	[illegible]	[illegible]
7. I.H.P. per ton dead weight of concrete ship	[illegible]	0.1[illegible]	[illegible]	0.28	0.[illegible]6
8. I.H.P. per ton dead weight of steel ship	[illegible]	0.[illegible]1	0.[illegible]1	0.2[illegible]	0.[illegible]

[illegible] of concrete will also [illegible] than the displacement.

[illegible] the above assumptions [illegible] are actual designs, and [illegible] has been found [illegible] was determined inde-pendently from first principles.

Table [illegible] gives the estimated particulars of steel ships of the same deadweight capacities.

Table [illegible] gives the comparative items between concrete and steel ships of the same deadweight capacity.

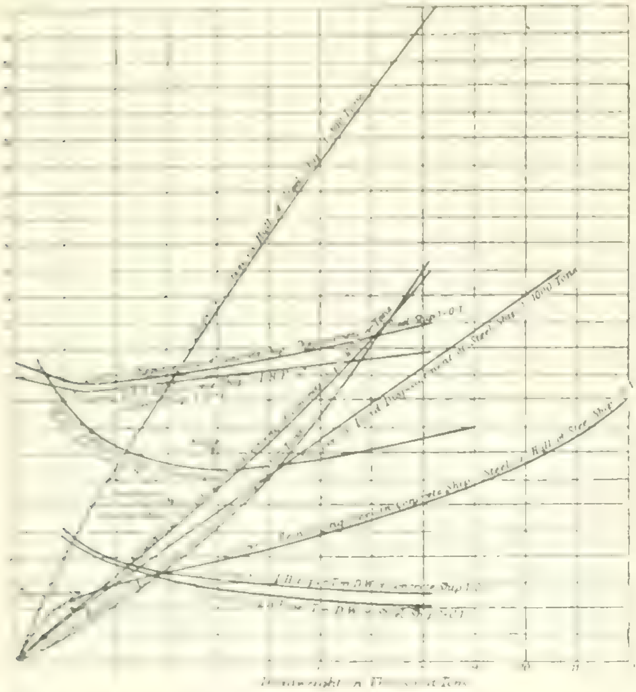
The following relationships have also been plotted as shown in the [illegible] diagram:

Curve 1C. Variation of displacement with deadweight for concrete ship.

Curve 1S. Variation of displacement with deadweight for steel ship.

Curve 2. Ratio of load displacement of concrete ship to displacement of steel ship.

Curve 3. Ratio of indicated horsepower of concrete ship to indicated horsepower of steel ship of same deadweight capacity.



Curves Showing Various Comparisons Between Concrete Ships and Steel Ships.

Curve 4C. Variation of tons of steel reinforcement with deadweight for concrete ship.

Curve 4S. Variation of tons of steel in steel hull.

Curve 5. Variation in ratio

$$\frac{\text{weight of steel reinforcement}}{\text{weight of steel in steel hull}}$$

with deadweight.

Curve 6C. Variation of indicated horsepower per ton deadweight for concrete ship.

Curve 7. Variation of cost of reinforced concrete hull per ton deadweight.

The displacements of the Faith, America's standard concrete ship, and "Concrete Shipbuilding at Barrow," are indicated on the curve 1C. The displacements of "Shipbuilding at Barrow," "America's Standard Concrete Ship," and the Faith, are all about 20 per cent more than would be anticipated from this curve, and this indicates that the concrete hull estimates which this curve represents make allowance for considerable improvements in design and materials, and are not pessimistic.

Examination of curves 1C and 1S indicates that the displacement of concrete ships above 1,500 tons deadweight becomes increasingly greater than that of steel ships. Curve 2 also shows this very clearly, and it would appear that at a deadweight capacity of about 1,500 tons the displacement of concrete ships makes the nearest approach to steel, being in fact only 7 per cent more.

The indicated horsepower ratio, Curve 3, naturally follows Curve 2, and at 1,500 tons deadweight the increase in indicated horsepower is only 4 per cent. Curve 6C shows that the indicated horsepower per ton deadweight does not decrease so rapidly with increase of deadweight as is the case with steel ships shown in Curve 6S. After 8,000 tons deadweight there appears to be no appreciable decrease in indicated horsepower per ton deadweight for concrete ships.

The saving in steel is an important economy of concrete ships, and Curve 5 indicates that the ratio

$$\frac{\text{steel reinforcement}}{\text{steel in steel hull}}$$

increases rapidly with dead weight. The saving in steel is about 77 per cent for 1,000 tons deadweight, 50 per cent for 6,000 tons deadweight, and probably becomes nil at about 12,000 tons deadweight. This alone indicates an economic limit to size of concrete ships.

The cost of concrete hulls is governed largely by the superficial area of hull. The cost of moulds, and steel placing varies directly as the area of the hull. It is possible that the total cost of labor on steel in a 2,500-tonner concrete ship would not be much more than for a 1,000-tonner. The tonnage of reinforcement would be about three times as much, but if individual bars are three times the area of similarly positioned bars in the smaller boats, such as ⅝-in. bars instead of ⅜-in. bars, the total cost of handling would not be much greater. In larger boats there is more room in which to place the moulds and generally the workmen are not working under such difficult and congested conditions. The cost of fairing fore and aft ends is not much more for a large ship that for a small ship, which is again an advantage in cost in favor of the larger ship.

The area of hull varies as $\sqrt[3]{D^2}$ and thus it would appear that the cost of concrete ships per ton deadweight decreases with increase of size of hull, with the exception of the cost of concrete and steel, which increases with the weight of material. Thus the cost of concrete ships can be divided into two parts; one varying with $\sqrt[3]{D^2}$ the other part directly with the weight of hull.

Curve 7 illustrates the variation in cost of concrete hull per ton deadweight, the figure for a 1,000-tonner being unity, the curve combining the effect on cost of weight of hull and area of hull surface. From Curve 7 the advantage in capital outlay of building 4,000-tonners is apparent, the cost per ton deadweight being 75 per cent of that of a 1,000-tonner, but after 4,000 tons deadweight, the cost per ton deadweight increases owing to the cost of materials becoming the predominating item.

The facts to be derived from these curves are:

1. After 1,500 tons deadweight the displacement of concrete hulls increases more rapidly than the increase of deadweight.
2. Minimum indicated horsepower per ton deadweight of concrete ship occurs at 8,000 tons deadweight.
3. Minimum cost of concrete hull occurs at 4,000 tons deadweight.
4. From (3) and (4) it would appear that the economic limit to concrete ships is between 5,000 tons and 8,000 tons deadweight.
5. At 1,500 tons deadweight the concrete ship is most favorably compared with a steel ship for displacement and indicated horsepower and at this deadweight the cost per ton deadweight is 90 per cent that of a 1,000-tonner.
6. The saving of steel at 1,500 tons deadweight is 74 per cent. The saving of steel at 8,000 tons deadweight is 38 per cent.
7. Vessels above 8,000 tons deadweight are not economic in concrete because:

(a) Saving of steel becomes negligible, and at 12,000 tons deadweight there is no saving in steel.

(b) Cost of hull per ton deadweight rapidly increases.

(c) Displacement rapidly increases and consequently indicated horsepower and net tonnage.

8. To conclude, concrete ships are most economical between deadweights of 1,500 tons and 4,000 tons, and the best size concrete ship, considering initial cost of hull, indicated horsepower and saving in steel, is in the neighborhood of 3,500 tons deadweight. No concrete ship under 4,000 tons deadweight should require more than 10 per cent extra propelling power compared with a steel ship of the same capac-

ity. In vessels under 1,000 tons deadweight the saving of steel is very considerable, being over 90 per cent for 100 tons deadweight, and this alone will in many cases lead to the adoption of concrete. If, however, the object is to increase tonnage at minimum cost and irrespective of size of ship, it would be advisable to build vessels of about 3,500 tons deadweight.

The above conclusions are based on a steel tensile stress of 7 tons per square inch. If higher tensile steel were used and the ratio of concrete to steel remained constant it would enable the weight of concrete to be reduced provided the concrte could stand the still higher demands made upon it. If this were possible the weight of hull would be reduced and the economic limit of size increased, but not very considerably.

Another possible means of reducing the displacement of concrete ships would be by the use of a concrete of lower specific gravity, and this is the most likely and immediate improvement.

Analyses of Sewage and Sewage Sludges

From Water and Water Engineering, March 20, 1919.

The following analyses have been made for the British Board of Agriculture:

1. SEWAGES—

Parts per 100,000

Type of sewage	Weak domestic, Slaithwaite.	Average domestic.	Manufacturing city	Strong domestic, Hampton.
Ammoniacal nitrogen	1.66	3.96	2.27	9.40
Organic nitrogen	0.89	1.91	1.02	3.14
Total nitrogen	2.55	5.87	3.29	12.54
Suspended solids	10.70	31.10	35.00	48.50

2. SLUDGES—

Per cent on dry matter.
1905—(a) Older methods of tank treatment
1918—(b) Newer methods.

	Lime and alumino-ferric precipitation, Dorking.	Septic tank, Leeds.	Slate bed sludge, Harpenden.	Activated sludge, Withington.	Activated sludge, St. Albans.
Organic matter	39.80	38.78	46.80	44.79	1
Inorganic	60.20	61.22	53.20	55.21	..
Total nitrogen	0.89	1.38	2.63	7.09	7.50
Phosphoric acid	0.66	0.66	0.34	3.75	.
Lime	23.16	9.28	. .	....	..
Potash	[illegible]	. . .	0.08	....	..

3. SPECIAL SLUDGES—

	Decreased sludge (Grossmann process).	Decreased sludge (Huddersfield)	"Native guaño" (Kingston). 1905.
Organic matter	35.5	59.8	51.25
Inorganic	64.5	40.2	48.75
Total nitrogen	1.55	1.87	1.93
Phosphoric acid	1.33	1.07	1.74
Lime	....	1.54	3.30
Potash	....	..	0.16

German Tests of Effect of Vibration Upon Concrete

From Deutsche Bauzeitung, Sept. 28, 1918.

In concrete construction it is generally believed that vibration during the period of setting has a bad effect, so that it must be prevented as much as possible. On the other hand, tests made by von Bach in 1905 on the frictional resistance of iron reinforcement in concrete showed that this was increased by vibration during setting and varied inversely with the quantity of water present in the concrete mass. The "German Committee for Reinforced Concrete" decided to make further tests to verify von Bach's results, and the figures are set forth in a pamphlet of eighty-eight pages, with thirty-three tables and numerous photographs of fractured tests beams. The vibration or shaking is divided into three classes, which are described in detail. The test beams of a transverse section 20 cm. by 30 cm. were laid across supports 2 mm. apart. They were made of concrete composed of 1 part cement to 4 parts of gravelly sand, or 1 part cement, 2 of sand, and 2 of syenite broken fine, and reinforced with iron rod 16 mm. section. Both kinds of concrete were used in three degrees of dampness. Fluid concrete is more sensitive to vibration than concrete with less water. The precise figures for surface friction in the iron are not given.

"Forest Plank" Roads

By MAJOR P. G. JOHN KEENAN

From The Royal Engineers' Journal

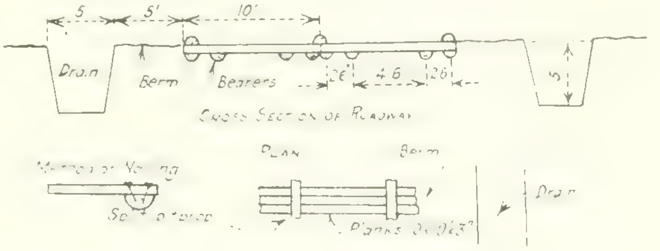
The many difficulties in the way of efficient repair of the paved roads of France, immediately behind the front lines, are obvious. Road material was scarcer and the difficulty of transporting it by motor truck over heavily congested roads, put ordinary methods of road making out of the question. Hence the "forest plank" road, which stood all tests satisfactorily, when it was well and truly laid.

The materials required for these roads are: Rough forest planks, 10 ft. by 10 in. by 3 in.; split pit props of at least 6-in. diameter; nails, 6-in.; sandbags.

The tools required include heavy hammers, rip saws, tracing tapes, heavy mauls, and picks and shovels.

The best plan is to divide your working party of pioneers or infantry into three: (1) drain-cutting party; (2) formation; (3) carrying party.

Wherever possible, lay the plank road over the remains of the old pave, which insures some sort of a foundation.



Cross Section of Plank Roadway.

Two methods are commonly used: single roadway, 10 ft. wide, with crossing points every 200 yd., and double roadway, 20 ft. wide.

The double road is the best, and in the end saves time. The methods of construction are as follows:

(1) Party is put on to cutting the side drains 5 ft. wide and 5 ft. deep, on either side of the formation, leaving berm of 5 ft. on each side of the roadway, thus making a total width of formation of 30 ft.

(2) Party drains all shell holes into the side drains, and fills hole with rammed earth, or preferably, with filled sandbags. This party also beds the bearers flush into the formation, in readiness for the sappers to nail down the planks to them.

(3) Party is employed carrying planks—two men to each plank—from the dump, which should be pushed up as near the job as possible by lorry.

The planks are laid at right angles to the bearers, with no camber. The ends of planks in the center of the road should be flush, and a split prop should be securely nailed down the center of the road to keep traffic on its proper side. It is also advisable to do the same on the outside edges of the planking. It checks side slipping in wet weather. All nailing should be on the skew. Wire nails are better than spikes, as the latter split the planking. The planks should be laid flush, otherwise the road will be kicked up by horse traffic.

The Divining Rod as an Indicator of Underground Water

From Water and Water Engineering, March 20, 1919.

The Society of Natural Sciences, of Wageningen, Holland, some time ago organized experiments in order to test the value of the divining rod. The results which have now come to our notice show that four diviners took part in the tests, which consisted (1) of tracing underground streams and controlling their courses in a given plot; (2) of determining whether underground conduits were full of water or dry. In many cases it was probable, and in some cases certain, that the rod did react to some apparently existent conditions. This shows that the apparent success of diviners is due to superficial control, conscious or unconscious, and to their observation and experience of the ground. Completely unfavorable results were obtained in searching for predetermined water currents; correct answers were obtained in 23 cases, and wrong ones in 25. The results of the experiments were, therefore, in contradiction to the claims of the diviners.

Liquid Oxygen Explosives

[illegible] compelled [illegible] authorities to [illegible] the [illegible] of [illegible]. Coal mines, [illegible] which used large quantities of these [illegible] were compelled to look for some [illegible]. This was a [illegible] for German engineers, who [illegible] 17 years had worked on the problem of [illegible] in the industry. The [illegible] of this explosive is entirely different from those [illegible] industrial or military [illegible] containing two essential [illegible], carbon, and an ignition [illegible] oxygen. The [illegible] is the result of the abrupt and violent combination of these two elements. Oxygen is introduced under the form of nitric combination or chlorinated combination; carbon in form of organic matter. With oxyliquit the liquefied oxygen is put in contact with carbon in a divided and porous form. Under a system of ignition, the combination takes place with explosion.

Liquid oxygen is always produced on the spot where it is [illegible] as it is impossible to prevent volatilization taking place shortly. It is prepared by liquefying the air, the resulting mixture of liquefied nitrogen and oxygen, being submitted to a partial distillation, which eliminates the larger part of the nitrogen, more volatile than the oxygen. The so obtained bluish liquid contains about 85 per cent of oxygen.

A German Society for the exploitation of the Linde patents is said to be able to furnish installations giving an hourly output of 23 lb. of liquefied rectified oxygen. The liquefied oxygen is transported from the place of production to the place of utilization in special containers.

Two methods of using the liquid oxygen for blasting purposes are employed. By the "Kowastsch" method the liquid oxygen is poured upon the lampblack in the bore-hole. A cylindrical cardboard cartridge the same diameter as the hole contains the lampblack or other porous material rich in carbon. It is closed at both ends with cardboard or cork. Two small tubes of thin cardboard pierce the stopper at the outer end. These tubes serve for the pouring of the oxygen also for the fuse or electric ignition system. A metal rod is inserted in each tube to prevent them being crushed, the cartridge placed at the bottom of the hole and packed with a wad of clay. The metal rods are then extracted and the liquid oxygen poured in by means of an elbow funnel. The explosion is comparable to that of dynamite.

The "Marsit" method allows of a more regular working and is therefore more in use than the other.

In this the cartridge is saturated before being introduced in the bore-hole. To do this the cartridges are immersed in a special vessel of cylindrical shape with double walls, filled with liquid oxygen. The cartridges are left first exposed for a few minutes to the vapors above the liquid, to cool them off, then completely immersed for half an hour. The saturation is therefore complete. When the cartridge is saturated, it is taken out, and the ignition system attached as quickly as possible; it is then placed in the bore-hole and tamped. The manipulation in this method is far simpler than in the first mentioned, the only inconvenience being the unavoidable delay between the taking out of the cartridge and the placing in the bore-hole. During the lapse of these few minutes a certain part of the oxygen of the cartridge evaporates. To lessen this loss, and to keep in the lampblack a sufficient excess of oxygen, the walls of the cartridge are made watertight: they are of corrugated cardboard. No detonator is needed to explode these cartridges, this being one of the advantages of the new method; all that is necessary is a small primer ignited by a fuse or by electricity.

The principal company manufacturing this product, the "Sprangluft Ges. m. b. H.," of Berlin, claims to have delivered each year an equivalent of 10,000 tons of nitric explosives. Even allowing for probable exaggeration, that shows how widely this product is used in Germany.

The greatest advantage of oxyliquit is that it almost entirely eliminates the danger of accidents. The cartridge itself is only explosive for about 10 minutes, between the time of its saturation and the time of its ignition. During this time the danger is not any greater than with any other explosive. The result of this advantage is that in case of a miss, it is only necessary to wait half an hour for the cartridge to become entirely harmless and so to be able to uncover the bore-hole without any danger. In addition, all danger inherent to transportation and storage of the explosive is entirely eliminated.

The method, however, has its disadvantages. The principal is, that it is impossible to store liquid oxygen, thus requiring a liquefaction and rectifying plant at the place where it is used. Also there is need of very experienced hands for a quick charging of the boreholes.

Theoretically, the new explosive may claim superiority. In practice, however, it gives an explosion hardly equivalent to the most powerful explosives known, the common dynamite and the gelatine dynamite.

The Flow of Water in Pipes and Pressure Tunnels

By FREDERICK JOHN MALLETT.

Abstract of paper read Feb. 27, 1919, before Institute of Civil Engineers.

The paper is an endeavor to trace out the inconsistencies met with in many of the older formulae, and briefly to set out the features that in practice determine the ultimate capacity of water mains.

Practically all the better known formulae have been examined and compared, and the formulae giving the most consistent results over a range of diameters from 3 in. to 120 in. have been tabulated. It was found that many of the formulae gave good results over a short range of diameters, but when extended to the diameters that are now coming into use they gave unreliable results. This is no reflection upon those who originated the formulae, as prior to 1910 only about a dozen pipes over 48 in. in diameter had been tested.

The well known Kutter-Flynn tables with a value of 0.013 for n have been extensively used by waterworks engineers, but while giving good results for mains, say, from 12 in. to 36 in. in diameter, for mains of small diameter the capacity was found to be greater than the formlua predicted, although the incrustation was the same in amount and character. This knowledge has compelled the adoption of a smaller value of n for pipes below 12 in. or so in diameter; or indeed sometimes of another formula. The necessity for two formulae or two values of n to determine with a degree of accuracy the discharge of mains similarly encrusted is objectionable.

It was with the idea of obtaining greater accuracy in determining the flow of water in incrusted mains that tests were made upon mains 3 in. to 30 in. in diameter, and upon their entire length, not in short sections or straight runs. These mains have been in use from twenty to sixty years, and the water is derived from the limestone and red sandstone formations which produce an incrustation corresponding to Kutter's $n = 0.013$. About the time these tests were completed (1916), Mr. F. C. Scobey's work on wood-stave pipes (Bulletin No. 376, United States Department of Agriculture) was issued. The experiments were made upon mains 8 in. to 162 in. in diameter, and form reliable data upon which to construct formulae for mains up to about 15 ft. in diameter. Since the date of Scobey's bulletin, the tests upon the New York water supply tunnels of 14½ ft. diameter have been issued, and these have been considered in the development of a new set of formulae for clean and incrusted mains.

It has been noted that in the past the greatest attention has been paid to the determination of coefficients and indices in formulae for clean mains, and then a very wide margin allowed for incrustation or ageing. Generally the allowance for incrustation is the same relative amount for the large mains as the small mains, which is not tenable. Several expressions have been introduced to determine the reduction in capacity of mains in a term of years, but these are also inconsistent with fact, since the incrustation depends more upon the class of water conveyed by the main than upon the number of years that the main has been in use.

New formulae for clean and incrusted mains are given; the nature and degree of incrustation is stated for each of three degrees of incrustation; and a general classification is made of waters which produce these incrustations. A survey of formulae and of the subject leads to the conclusion that the Chezy formula, when a varying value of C determined from the value of n introduced, as ascertained from the class of water to be dealt with, is the best for practical purposes.

The Future of British Canals

From Water and Water Engineering, Feb. 20, 1919.

It was generally expected that the war would be the opportunity of our British canals, whose welfare has been considered so tenderly and to so little purpose by the Royal Commission on Canals and Inland Waterways, the capacity of their inveterate competitors—the railways—being strained to breaking-point. Yet by the end of 1916, according to one witness, "the end of canal carrying was in sight, and at the same moment its importance was realized." The reason was that the railways were unable to raise their rates or to refuse traffic, whereas the canal carriers or by-traders, owing to the higher cost of labor, forage, etc., were compelled to raise their charges, while the army at the same time made repeated calls upon their staffs; consequently the railways were compelled to carry goods that had always hitherto been conveyed by barge.

The Canal Control Committee was appointed at the beginning of 1917, under the chairmanship of Sir Maurice Fitzmaurice, who gives an enlightened account of the methods adopted to increase the usefulness of the canals which were taken over; these measures included financial guarantees, organization of traffic, and the training of men in canal work. In the course of this work Sir Maurice Fitzmaurice has been able to consider the financial and engineering questions involved in a development of canals after the war. He estimates that the cost of improving and acquiring the canal routes forming what has generally been called the "Birmingham Cross," so as to make them suitable for the size of boats recommended by the Canals Commission on a post-war basis, would be as follows:

		Length, miles.	
A	Birmingham and Leicester to London ...	348	£12,345,151
B	Leicester, Burton and Nottingham to the Humber ...	277	6,182,963
C	Wolverhampton and Birmingham to the Mersey ...	157	8,451,184
D	Wolverhampton and Birmingham to the Severn ...	122	6,839,356
	Total ...	904	£33,818,654

This materially increases the estimate of the Commission, which was £17,533,910. The above total, however, includes £6,000,000 for the purchase of the canals, but it does not make provision for the erection or construction of inland harbors, wharves, warehouses, etc., estimated to cost a further £10,000,000.

Sir Maurice Fitzmaurice was skeptical as to the possibility of securing a return for this heavy expenditure; even regarding the canals themselves as a free gift, he said it would be necessary to expand the traffic five-fold before the canals could be said to pay their way. He suggested, however, that expenditure of something like £3,000,000 to put the existing canals in a thorough state of repair, so as to enable them to deal more efficiently and economically with approximately the same class of boats which use them at the present time, might be justified; in addition, he recommended the outlay of a further £1,000,000 on the making of a new dock at Sharpness. The Committee thinks that the scheme is worthy of consideration, at the same time being of opinion that the projected establishment of central power stations, which would necessarily have to be erected at places where large supplies of water are available, generally in the vicinity of large estuaries, must greatly influence the future of canals, the bulk of whose traffic has in the past been coal.

Of greater immediate interest is the account given by Sir Maurice Fitzmaurice and Mr. I. T. Williams, who represents the railways on the Canal Control Committee, in regard to experiments that have already been carried out during the war to improve the efficiency of the canals. These have lain principally in two directions, viz.: (1) The substitution of lifts for locks, in order to economize water and accelerate transit; and (2) increase of speed by various methods of propulsion. The latter was also prompted by the shortage of man power. It was found, however, that, on many of the canals, an increase of speed above four knots had an injurious effect upon the banks of the canal. It has not been clearly ascertained as to whether this is due to the bow-wave or to the action of the propeller; experiments on the Birmingham navigation with a motor-boat, specially constructed to prevent a wash, are now being carried out, but up to the present, mechanical propulsion has been only moderately successful, owing partly to difficulties in crowded locks and to frequent stoppages. The figures quoted by Mr. Williams show a heavier cost of maintenance when compared with horse-haulage and no appreciable increase in speed, owing to the time lost at the locks. In this connection it might be considered also whether the petrol-driven vessels, known as "L" and "K" lighters, constructed for the navy for landing purposes, could not be profitably employed after the war on canals and rivers.

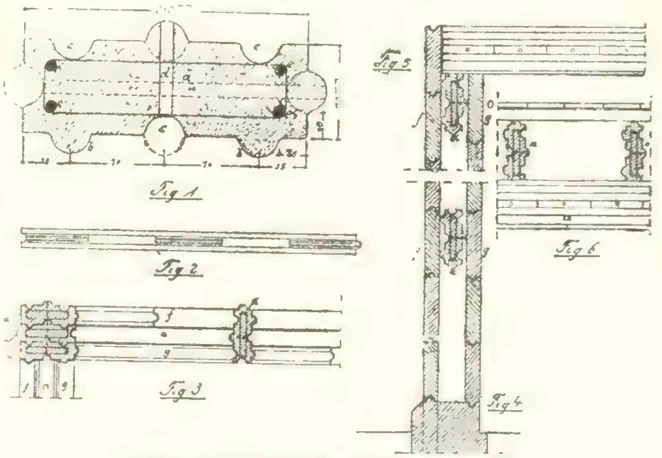
The substitution of lifts for locks would be instrumental not only in accelerating traffic, but in economizing water supply. There are several canals in this country where locks occur every half mile, whereas the general average on the Continent, even on the canalized portion of the rivers alone, is not more than one in every two miles. Lifts are provided on many canals abroad, and they have been successfully adopted in this country on the Weaver Navigation, but it would be necessary to face a heavy capital cost to contour the canals so as to increase the lifts; the cost of such works is difficult to estimate, but Sir Maurice Fitzmaurice states that a scheme has already been drawn up for improving the connections on the Grand Junction Canal at Walford, near Leicester.

Generally speaking, the policy outlined is to utilize the canals as feeders of the railways for heavy short-distance traffic, as part of a general scheme of unification of transport facilities. It is clear that, without embarking on grandiose schemes of doubtful value, much could be done by a comparatively small expenditure to utilize inland waterways that are now little more than a public nuisance, but that such works are frequently beyond the powers of private companies.

Unit System of Reinforced Concrete Construction for Small Houses

The following description of the "Klip" system for using reinforced concrete in the construction of small dwellings is abstracted from an article of Dr. Warner Scheibe, government architect of Klotzsche in Deutsche Bauzeitung of Aug. 17, 1918:

The unit building block is 210 mm. long by 70 mm. in cross section and of such a length that it can be carried by two men. It is reinforced by four thin rods wired together at intervals. One edge has a semi-circular groove and the other a rounded projection, while one flat side has two projecting ribs and one groove to correspond with two grooves and one rib upon the other face.



Details of Reinforced Concrete Work.

The piers of the building are constructed of such blocks placed vertically; three, for example, being bolted together, while the spaces between the piers are formed by the same type of blocks laid horizontally with an air space of 10 cm. between the inside and outside skin. Where window openings are required a standard slab is inserted in the air space. The floor joists, partitions and roof are constructed of similar standard slabs, and it is stated that spans up to 6 m wide can be adopted. The construction is so simple that unskilled labor and women can be employed under the direction of one skilled man. As soon as the plastering and fixing of windows and doors is completed the houses are ready for occupation. The cost per sq. metre of wall surface, inclusive of floor joist erection, is stated to be 28 to 30 ct. per square foot of surface. The cost per cubic meter of the finished house is about 17 to 20 ct. per cubic foot.

Strength and Elasticity of Electrically Welded Joints

[illegible]

[illegible] of an alternat[illegible] [illegible] of welded joints to [illegible] Experiments [illegible] with in [illegible] of place must [illegible] of tests carried [illegible] and described [illegible] before the Institute of Civil Engineers by their chief ship surveyor, Mr. W. S. [illegible] will be very [illegible] which covers [illegible] nothing to be desired. Particularly valuable are the results of the alternating [illegible] of this nature had pre[illegible] welded joints.

The first type of apparatus employed for these tests was designed on the same principle as that employed by Wohler in his well-known experiments many years ago. The specimens, which were in the form of round bars, were fixed in the grip of a lathe which revolved at about 1,000 r.p.m., and loads were so arranged that the part of the bar containing the weld was subject to a uniform bending moment of known amount, the stress on each part of the material changing during each revolution from compression to an equal stress in tension. The bars were tested in pairs, one welded and the other unwelded, and the results tend to show that the highest stress at which the welded bars will withstand a very large number of repetitions of alternating stress is about 6½ tons per square inch, as against 10½ tons per square inch in the case of the unwelded bars.

An alternative form of this type of test was also devised in which the specimens used were flat plates 14 in. in length by 5 in. in breadth. The specimens were clamped at the ends while a center clamp was caused to oscillate and to bend the specimen equally up and down, the maximum total displacement used being 5/16 in. The results obtained corroborate those given by the first method, it being found that the stress at which a flat plate with a butt weld is able to endure a large number of alternations is about 70 per cent of the stress borne by the similar plain plate.

Closely allied to the foregoing, and indeed in large part responsible for the results obtained, is the crystalline structure of the added material and the structural changes produced in the original steel adjacent to the weld by the heat of the welding.

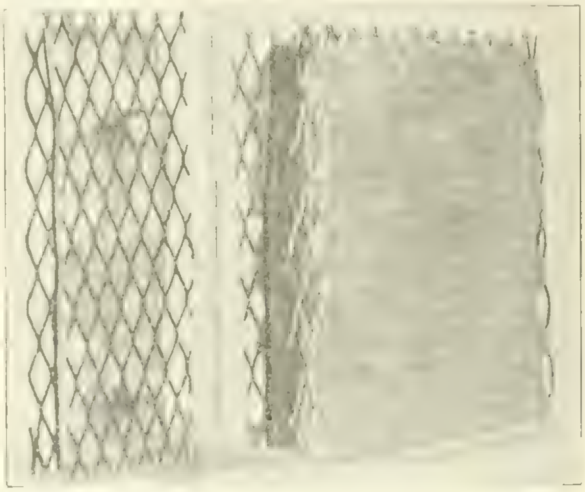
In the design of large welded structures one of the most important properties of the welded joints is the relative value of their modulus of elasticity as compared with that of mild steel, and in the experiments with which we are now dealing, special attention was paid to the determination of this value. As is well known, the value of Young's modulus for different qualities of steel varies very little and does not appear to be affected by the percentage of carbon present. This conclusion is fully borne out by the results of the experiments in which this property of the joints was determined by several different methods of measuring the extension in way of the weld as well as by observations on test pieces composed entirely of deposited material. The ultimate extension of welded joints is, of course, much less than that of ordinary steel, but this is a feature of minor importance since in all cases the calculated structural stresses are kept well within the elastic limit.

Taking a broad line through the results of these tests it may be said that it has been shown that with careful workmanship, welded joints may be reasonably expected to successfully withstand the stresses experienced by a structure in which the calculated stress does not exceed about 6½ tons per square inch when the stress is of an alternating nature and varies from tension to an equal stress in compression, with possibly a somewhat higher limit when the conditions are less severe. The ultimate strength of the welds is practically always in excess of that of riveted joints, and the elastic properties are quite satisfactory, while the microscopic examination shows that there is no abrupt change in the crystalline structure at the junction of the original and added material. To secure the best results, it is essential that the operators employed should be thoroughly trained, a point which is receiving the attention of firms principally concerned. The possibility of effecting appreciable economy in material is one that must not be overlooked, although the claims of some of the advocates of electric welding are probably unduly optimistic.

New System of Concrete Reinforcing

From The Surveyor, Jan. 31, 1919.

A new patent system of reinforced concrete recently placed on the market consists of an outer and an inner surface reinforcement of expanded metal or similar material, bolted together by properly spaced distance pieces, which also secure a bituminous sheet placed at the neutral axis. This bituminous sheet may be described as the principal characteristic of the system, and it provides many of the advantages claimed. For example, it is stated to enable the concrete itself to be applied in situ, thus avoiding the necessity for any boxing or shuttering—a most important economy in view of the present shortage of timber. Again, it renders the wall in which it is placed impervious to both damp and sound. The "M. P." Concrete Construction, Ltd., with offices at 13 St. Helen's place—London, E. C.3—has been formed to work the patents.



The M. P. Concrete Reinforcing System.

War-Time Repairs to a Steam Roller

From The Surveyor.

The hind roller of a Norwich Corporation machine having collapsed, and, by reason of the war, it having been found impossible to purchase new rollers, the city engineer, Mr. A. E. Collins, M. Inst. C. E., devised a system of repairs which, as far as he knows, is novel. He pieced together the collapsed shells and steel tires, placed necessary reinforcement in position within shells and spokes, and filled up the roller shells with concrete made from "Ferro-crete" cement and local shingle and sand.

Roller Repaired With Concrete.

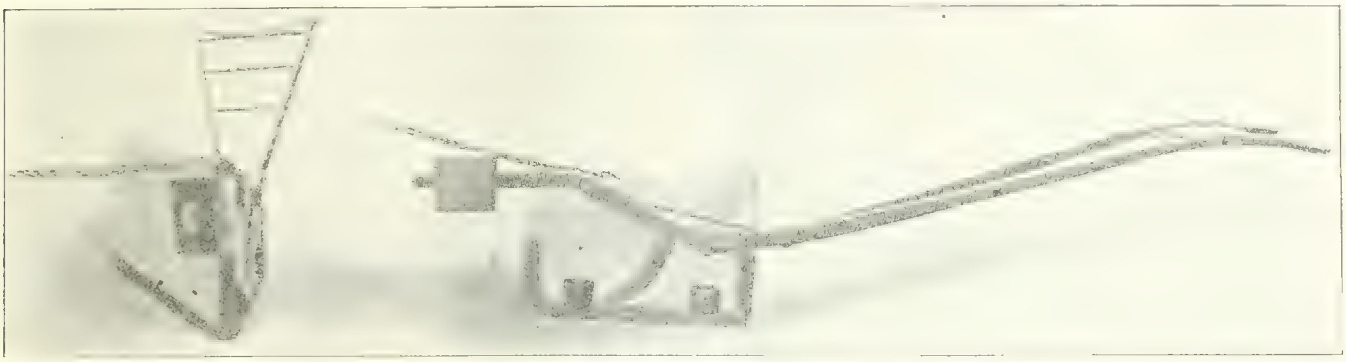
To distribute the local stresses on the tread to the body of concrete he placed 6-in. coils of ⅝-in. round iron, each about 9 in. long, resting against the interiors of the shells and inclined towards the center of each roller wheel.

The result of the repairs has been entirely satisfactory, and the roller has been in constant use for 18 months since. While it is somewhat more difficlt to steer than formerly, it is a better roller than before for straightforward work by reason of increased weight, and it is the favorite corporation roller for tar-macadam and tar-paving work.

Snow Plow for Street Gutters

From The Engineer, Feb. 11, 1919.

A snow plow which has been found very effective in clearing drainage channels at the side of roadways has been designed and put into service by Mr. George Nelson, A. M. Inst. C. E., engineer and surveyor to the Gosforth—Northumberland—Urban District Council. The machine, to which the name of the "Rapid" Street Channel Snow Plow has been given, is illustrated in the accompanying engraving.



Street Gutter Snow Plow.

The body part is made of well-seasoned redwood, firmly bolted together with ⅝-in. bolts, and the base is shod with a sole piece of Bessemer steel, turned up on the sides of the body, and extended to form the nose on the front. The three-sided frame on the near side is also of Bessemer steel, and the shafts or stilts, which are of wrought iron, are bolted to the three-sided frame and also to the inside of the body. An arm or beam of forged iron projects over the front portion of the plow, and carries a cast iron counterpoising weight, which can be adjusted to suit the varying density of the snow. There is a pair of anti-friction rollers made of cast iron on the near side. These rollers revolve against the vertical face of the street curb and serve to reduce the friction set up by the thrust of the snow on the offside face of the plow.

Australia Adopts American State Aid Plan for Roads

From The Surveyor, March 21, 1919

The complete change of policy in the care and management of the more important highways of the country districts of the State of Victoria, which the passing of the Country Roads Act involved, a change from a system of disintegrated local municipal control to one of partnership between the State, represented by the board as the central authority, and the local municipal councils, was received in many quarters with considerable misgiving; but it is satisfactory to record that, in districts where there was not only passive resistance, but actual hostility, the merits of the new scheme of finance and control are at last being appreciated.

In many parts of the State road construction for many years had been almost non-existent—in fact, of some districts it can be said that it had scarcely been commenced. The reason is obvious. Councils and the ratepayers they represented did not appreciate the value of good roads. They were loath to recognize that their road systems could not be built out of their limited revenues any more than the State could build its railway system without borrowed money, and, being reluctant to avail themselves of the borrowing provisions of the Local Government Act, they were content to remain as they were. Not only were they unable to build new roads, but with their limited revenue, often the product of a 1s. or 1s. 3d. rate on a low valuation, they could not even efficiently maintain the roads that already existed, with the result that in many instances well-built roads, constructed many years ago under a different system of road management, were allowed to deteriorate to a very serious extent.

The experience of the past five years, however, has convinced those local bodies that have availed themselves of the financial provision of the Act, and also the traveling public throughout the State, of the advantage of the present system over that which existed previously. They realize that the new system means regular and adequate provision of funds for maintenance, the provision of funds for new construction work, including bridges, to an extent that could not be contemplated by the unaided efforts of local councils, and the execution of works of a standard and character of permanency that could not previously be entertained. The educative effect of the new policy on public opinion has also been most encouraging, in that the question of road construction and maintenance, which previously had been relegated to the background, has been now raised to a foremost position amongst State activities in public expenditure.

The decision of the Government and Parliament to provide additional funds for development or feeder roads to the main road system has given an immense amount of satisfaction in country districts, where the conditions are such that the local bodies would not unaided, be in a position to undertake such work for generations to come.

British Road and Bridge Programme for 1919-20

From The Surveyor, Dec. 20, 1918

The Government has agreed that, having regard to the desirability of stimulating employment on useful work at the present time, the expenditure of highways authorities in charge of the more important roads in Great Britain on the basis of their pre-war program of renewal and maintenance, enlarged as these will necessarily be by the rise of prices, shall be supplemented by grants in aid for additional work to an aggregate amount of £10,000,000, of which £1,750,000 will be provided out of the Road Improvement Fund towards works of improvement and £8,250,000 will be drawn from the National Exchequer.

Mr. W. Rees Jeffreys, the secretary, states that the board has represented to the Government that the most useful kind of road work required at the present time is the strengthening, reconstruction, and resurfacing with improved materials of important roads and bridges, and that the lengths of road to be first dealt with should be those on which there is, or is likely to be, a large volume of heavy motor traffic, keeping in view, in the selection, all roads carrying considerable traffic, whether main roads or district roads, which have suffered deterioration during the war. It is recognized that the work of deferred renewal and maintenance will, in the immediate future, throw upon highway authorities a considerable amount of additional expenditure, and that all work carried out next year will cost more than it would have done at pre-war prices. In view of these circumstances, the board recommended that some special financial provision should be made

No highway authority will be entitled to share in the new grants for additional work unless they submit a statement showing that they are arranging to execute, out of their own resources, at least as large a program of road work as they carried out in the year ended March 31, 1914, or, in special cases, on the average of three years ended March 31, 1914, having due regard to the increase which has since taken place in the cost of executing road work, and are also making the maximum practicable provision to deal with works of deferred maintenance.

The Training of a Municipal Engineer

By [illegible]

[illegible]

The writer [illegible] that the case of nearly every individual who proposes to enter the municipal engineering profession differs, and that it is very hard to lay down any one set of rules in which there is no exception. Take the case of a youth whose parents can afford to spend a good sum on him. In the writer's opinion he should at 18 years of age enter a university with the object of taking an engineering degree with the thorough knowledge of one modern language (preferably French, which is spoken all over the world, or Spanish, Italian, or German). During the college vacations in the first and second years he should enter a mechanical engineering works. There he can master the application in practice of the principles of mechanics he has learned and get a practical working knowledge. The third year's vacation should be spent on a surveying course, such as is planned by the University College, London. He has then laid the foundation for his entry into the engineering profession. He should then be articled for two years to a good municipal engineer, with whom he can get a varied experience, which is so essential for his future welfare.

A certain portion of his time each week should be set apart for him to attend lectures on building construction, quantities, chemistry of building materials, town planning, municipal law, etc., and his chief should be responsible for seeing that his pupil has made himself reasonably proficient in these subjects and has not wasted his time. Further, he must instill into the pupil that his work must be directed towards passing the Institution of Municipal and County Engineers' examination, and that an engineer must continue to study and learn as long as he is in the profession if he wishes to get to the top of the tree.

In the case of a youth who cannot for various reasons take an engineering degree before entering an office, the following course is recommended by the writer: Enter an engineer's office as articled pupil for 4 years, having if possible, passed the matriculation examination of the London University. His chief should then map out his course of study as follows: First year—second or third stage of mathematics, elementary theoretical mechanics, elementary applied mechanics, elementary drawing. Second year—advanced theoretical mechanics, physics, chemistry. Third year—advanced applied mechanics, chemistry of building materials, building construction. Fourth year—statics of structures, including graphic statics, advanced building construction, surveying.

During this time he should pass the students' examination of the Institution of Civil Engineers. It is assumed that if a boy leaves school at 16 he has practically reached the standard required for the students' examination. The course of study mapped out above is primarily with the view to passing the associate membership examination of the Institution of Civil Engineers, as the pupil must be made thoroughly to understand that the principles of mathematics and mechanics must be mastered before he can become an expert engineer. This examination is a test as to whether he has mastered these principles or not.

After he has finished his term as articled pupil he should have attained a sufficient knowledge to earn his own living. Being able to earn money must not mean that the young engineer has finished his studies; rather he must redouble his efforts, and for another two years should concentrate his energies in specially studying the subjects required for the associate membership examination, as follows: Theoretical and applied mechanics, theory of structures, strength and elasticity of materials, hydraulics, geodesy, theory of heat engines, metallurgy or magnetism and electricity. If the above course is followed he should be ready to sit with success at 22 years of age. Should he not be successful he must sit again. Then, when passed, the following two years' course must be taken to prepare for the Municipal and County Engineers' examination:—First year: Building construction, quantities, sanitary science, elementary design of municipal works. Second year: Municipal law, engineering, sanitary science. If he worked moderately hard on these subjects he should be able to qualify quite easily within this period. The difference between these two courses is that the former has an easier path and is two years in advance of the latter. These two years can be spent in the pursuit of further knowledge such as valuations, reinforced concrete construction, etc.

The last decade has seen a greater expansion of municipal energy and enterprise than ever was anticipated, and to-day municipal engineers stand on a threshold and know not what awaits them except hard work which will tax their energies and knowledge to the fullest extent. Therefore in my opinion it is absolutely essential that a very high standard of education should be insisted upon in order to cope with the problems that will arise.

If a parent asked the engineer to whom he wishes to article his son the following question—"what can my son earn when he has finished his pupilage?" I wonder what the answer would be? Thirty shillings per week before the war—and what now? What is an adequate salary to give for this man's work and knowledge? A joiner when he is 22 years of age and out of his time can to-day command 1s. 9d. per hour, and for a 48 hours' week £4 4s., equal to £218 8s. per annum. What the Status Committee recommended in 1918 for a qualified assistant as deputy-engineer or chief assistant is £200 per annum, rising by annual increments of £10 per annum to not less than £300. I presume an assistant could not get this money until he was 28 years of age, and by the time he was 38 years rise to the sum of £300. It is the writers' opinion that councils would look at these figures as a maximum and not the minimum, as in the report. Therefore this report ought to be more clear, and salaries put on the basis of a professional man and not on the basis of a clerical assistant, as the professional man has to devote much money and time to study.

Many chief surveyors of small but important districts are not getting £218 8s. A pertinent question must now be asked. What are the heads of our institution doing to ensure that a young man shall have a proper and thorough training and an adequate salary when he has obtained that training? It is essential that all who enter the profession should pass an examination like a doctor or solicitor. A proper salary could then be commanded. In the writer's opinion a man of 25 years of age who has gone through either of the above courses ought to obtain from £300 to £360 per year, and not, as some men to-day, at 30 to 40 years of age, £200 per annum. This is a disgrace, and it ought to make everyone bestir themselves to obtain better conditions.

Estimating Hardness in Water

From Water and Water Engineering, Dec. 20, 1918.

The amount of reagents required for softening water by the lime-sodium carbonate and lime-sodium hydroxide methods may be calculated from the total hardness and the carbonate-hardness, non-carbonate hardness, and magnesia hardness, respectively. In determining the total hardness by Blacher's method with potassium palmitate solution, according to H. Noll, zinc and iron do not interfere with the process, as stated by Zink and Hollandt, provided they are first precipitated by means of sodium hydroxide. The carbonate hardness is determined by titrating the water with standard acid, with methyl orange as indicator, and the magnesia hardness by the following modification of the method of Froboese:—100 c.c. of the water is rendered neutral to methyl orange with hydrochloric acid, then boiled for 10 minutes, treated with 5 c.c. of a saturated solution of sodium oxalate, and again boiled for one to two minutes. After the precipitate has subsided, the liquid is titrated with N 10 potassium palmitate solution, with phenolphthalein as indicator.

The number of cubic centimetres required multiplied by 2.8, gives the magnesia hardness in German degrees (one German degree = 40 milligrammes CaO per 100 c.c.). The carbonate hardness multiplied by 10 gives the amount of lime in milligrammes, per litre of water required to convert bicarbonates into carbonates, while the magnesia hardness multiplied by 10 gives the amount of lime (milligrammes per litre) required to convert the magnesia carbonate into hydroxide and magnesium chloride and sulphate into the corresponding calcium salts. The non-carbonate hardness, multiplied by 19, gives the amount of sodium carbonate required (milligrammes per litre), but in practice it is necessary to add an additional 10 to 20 per cent. As a rule, water rich in salts requires a smaller excess than a water containing a small amount of salts. The same data are used for calculating the amounts of reagents required for the lime-sodium hydroxide process.

In the case of a water in which the carbonate hardness, excluding magnesia hardness, is greater than the non-carbonate hardness, the latter multiplied by 14.3 gives the milligrammes of sodium hydroxide required per litre, whilst the sum of the carbonate and magnesia hardness, less the non-carbonate hardness multiplied by 10, gives the amount of lime required. To give the necessary excess of sodium carbonate the amount of sodium hydroxide should be increased, and that of the lime reduced by quantities corresponding with one degree of hardness, and for this purpose sodium carbonate must be added to waters in which the carbonate hardness does not exceed the non-carbonate hardness by at least one degree.

Where the combined hardness due to carbonates and magnesium salts is greater than the non-carbonate hardness, whilst the carbonate hardness is equal to or less than the non-carbonate hardness, the amount of sodium hydroxide required is obtained by multiplying the non-carbonate hardness by 14.3, and the lime by subtracting the non-carbonate hardness from the sum of the carbonate and magnesia hardness and multiplying by 10. In the presence of magnesium bicarbonate in waters of this type, sodium carbonate should be added in a proportion corresponding with 1 deg. (= 19 milligrammes per litre). In the case of waters in which the combined carbonate and magnesia hardness is equal to the non-carbonate hardness, the latter multiplied by 14.3 gives the required amount of sodium hydroxide. In this case no lime is required, and an excess of sodium carbonate must be added to the water. In the case of waters in which the combined carbonate and magnesia hardness is less than the non-carbonate hardness, the sum of the carbonate and magnesia hardness multiplied by 14.3 gives the sodium hydroxide; the carbonate, plus the magnesia hardness, less the non-carbonate hardness, multiplied by 19 gives the required amount of sodium carbonate. For softening alkaline water lime only is required.

Reinforced Concrete Railway Tie

From Concrete and Constructional Engineering

The Port of London Authority has carried out numerous experiments in the production of reinforced concrete ties for use under the tracks at its various docks. These include ties of the heavily reinforced kind, 9 ft. by 10 in. x 5 in. and also those of the block or pad type. Of the former several hundreds are being made for tracks of 7 ft. gauge to carry 5-ton traveling steam cranes of large radius for use at the various dry docks belonging to the Port Authority. Of the latter only one need be mentioned here, wherein the object desired was to obtain a cheap and easily made block or pad tie for ordinary gage tracks, and at the same time dispense, if possible, with perishable wood or metal ties connecting the pairs of rails or pads. This tie was patented by J. H. Walker, an engineer of the Port Authority, and is shown in Fig. 1. It consists of a pair of blocks to which the rails are attached, separated by an intermediate block lying between them but not attached to them in any way. The special feature about the rail blocks is that their bases are inclined downwards towards the center of the track, as seen in the illustration. By this means it is found that whereas the tendency of sleeper blocks placed on a level bed is to creep outwards on account of the action upon the rails of the wheel flanges, the tendency of these blocks is to creep inwards; this is due to the compensating influence of the inward inclination of the bases, and is met by the intermediate block. No chairs are used, the rails being bolted down to the blocks themselves.

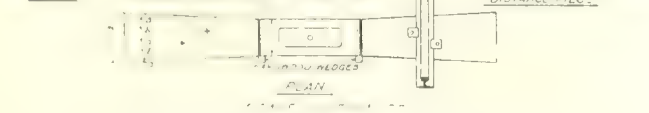


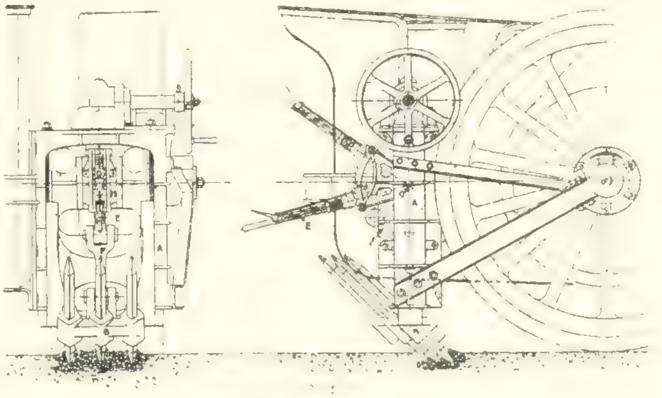
Fig. 1—Reinforced Concrete Pad Railway Tie.

These ties have been in use on the main goods line for over a year, and are perfectly satisfactory. As a result of the experience thus acquired it is considered that the intermediate block is only necessary at intervals, say, between every fourth or fifth pair of rail blocks. The test which these ties is undergoing is all the more severe in that they are laid in the curved track upon a recently widened embankment, where the ballast consists of the ash filling of which the bank is composed.

A New Road Scarifier

From The Engineer, March 14, 1919

A new form of scarifier has recently been brought out by Marshall Sons & Co. of Gainsborough. The device has the main features generally associated with this class of machine. That is to say, a set of inclined, hard steel tines are fixed in a frame attached to the rear of a road roller and forcibly dragged through the road surface. The new Marshall scarifier has, however, a very useful addition, which greatly expedities work where there are obstructions, such as tram rails and gratings in the road. With the ordinary scarifier it is necessary laboriously to wind the tines out of the cut, to clear the obstruction, and then force them down again on the other side. This frequently necessitates the engine being stopped, and means that the cut of the tines cannot be carried to the full depth on both sides of the obstruction. To overcome this trouble a quick-lift toggle action has been fitted to the frame carrying the tines. Referring to the line drawings, it will be seen that the main frame A is rigidly bolted to the engine tender and stayed to the back axle by means of a steel channel and an angle. The frame itself is of cast steel, and is machined on the inside to carry the sliding frame. The sliding frame has, at its lower end, the tine holder B, which has three slots, arranged en enchelon for the reception of the tines. The sliding frame is connected with the crosshead H by means of the links F and the bell-crank E rotating about the pin G in the crosshead. The crosshead is free to slide in guides machined in the main frame, and is adjusted vertically by means of the screw D, a set of bevel gears and the hand wheel C. The bell-crank lever E has a pawl engaging with ratchets on the quadrants J. Thus there are two means of moving the time holder in a vertical direction. The hand wheel enables the depth of cut to be adjusted, while the lever and links give a quick lift, for clearing obstructions, which amounts to about 5 in. On either side of the frame there will be seen two long vertical bolts. These bolts extend right through the sliding frame, and are surrounded by strong springs which balance the weight of the tool box, and thus assist the attendant in lifting the tines quickly out of the cut. When the lever E is fully depressed the links are in a straight line, so that the reaction of the tines in tearing up the road surface is transmitted direct to the crosshead and the lever is relieved of all strain.



Arrangement of the Marshall Scarifier.

Cost of Road Resurfacing with Tarmac

From The Surveyor, Jan. 24, 1919

During the four years 1914-18 the County of Notts, England, resurfaced 90 miles of rural main roads.

The work carried out under the scheme comprised the resurfacing of the roads with a center of tarmac 10 ft. in width (laid in two coats), 3½ in. thick when consolidated with 4 ft. of water-bound granite or slag on each side.

One of the disadvantages of this system is that "potholes" soon made their appearance along the edge of the tarmac. This has been stopped to a large extent by adopting what may be described as a lap joint between the tarmac and the water-bound macadam sides, the bottom layer of 2¼-in. tarmac being laid 6 in. wider on each side than the topping coat, and the untarred granite or slag being rolled into it

Experimental lengths of granite laid with rocmac were laid on the side of the tarmac in the hope of obtaining a better [illegible] ordinary water-bound [illegible] laid in 1915 on a road [illegible], it has stood very well, [illegible] on a road having a [illegible] began to show signs [illegible] at the joint with the [illegible] tar-sprayed, and has been [illegible] and is still in good condi[illegible]. [illegible] was, however, quite as [illegible] 6d per yard [illegible].

[illegible] the quantities of materials [illegible] miles of road carried out direct by the county council, and the cost per ton of the materials in the various years. The cost per yard of the finished work is also given:

			Average price per ton	
		[illegible]	[illegible]	1917-18.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]	[illegible]	1917-18.
Tarmac	2/6	3/2
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1/[illegible]

Water Power of the World

[illegible] Water Power Committee [illegible] Society.

It is impossible to estimate with any pretensions to accuracy the power now being used in the various countries of the world. Independent estimates, based on such data as are available, tend, however, to show that it is of the order of 120,000,000 h.p., made up approximately as follows:

	Millions of horse-power.
World's factories, including electric lighting and street rail-[illegible]	75
[illegible]	21
[illegible]	24
Total	120

This includes all steam, gas, and water power.

Of the 75,000,000 h.p. used for factories and general industrial and municipal activities, a rough approximation of the most probable distribution would appear to be:

	Millions of horse-power.
United Kingdom	13
[illegible]	24
[illegible]	29
[illegible]	6
[illegible]	3

An estimate by the Dominion water power branch of the Canadian Department of the Interior outlines the hydraulic situation of the various countries as shown in Table I.

From this it appears that between 15,000,000 and 16,000,000 of the world's industrial horse-power is at present developed from hydraulic resources. The following table shows approximately the hydraulic power developed in the various regions, and also the ratio of this to the total industrial horse-power (excluding railways):

	[illegible] Kingdom.	Continental Europe.	United States.	Colonies.
[illegible]	[illegible]	[illegible]	7.0	2.0
Percentage of total industrial h.p.	0.6	27.0	24.0	33.0

Perhaps the most interesting feature of these tables is the extremely small proportion of available hydraulic power developed in the United Kingdom. It is the most backward in this respect of all the countries listed, except Russia, and its 8.3 per cent compares very unfavorably with the 43.4 per cent of Germany.

Simple Method for Extracting Dissolved Gases from Water

A simple and satisfactory method for the extraction of gasses dissolved in water is described as follows in Water and Water Engineering for March 20, 1919:

A stout glass quart bottle is completely filled with the water. The lower tube of a bulb of thistle funnel head, of 50 c.c. capacity and provided with two stoppers, is passed through a rubber stopper, the bulb is evacuated, and the stopper inserted in the bottle, thereby connecting the tube with the water. When the lower tap of the bulb is opened a little of the water rushes up, and it becomes possible to press the cork firmly into the bottle neck. Evolution of gas at once begins. If the bottle is placed in a vessel of water at about 40° C., and the gases occasionally removed from the small bulb, the water will continue to boil until all gases have been removed. Carbon dioxide is tenaciously held by water, and when it is present alone repeated evacuations of the small bulb are necessary, but a number of experiments have proved that carbon dioxide can be completely removed from the apparatus. For example, a quantity of distilled water was boiled for two hours, and then quickly cooled. The quart bottle was three-fourths filled with the water, and 0.1 grm. of pure sodium carbonate was added, followed by an excess of dilute sulphuric acid; 21.0 c.c. of gas was recovered, whereas theory required 21.06 c.c. When the water contains much dissolved air in comparison with the amount of carbon dioxide, the latter is more easily removed, as the other gases help the evacuation.

Method of Reconstructing Road on Clay Subsoil.—It is truly said that the best experience is not obtained by success, but through work of some kind or other not turning out to be the complete success desired, and in this respect the writer had a useful experience in 1915, it being necessary in that year to deal with a road which had been constructed on a clay subsoil with a foundation of lump slag covered with 3 in. to 4 in. of slag rejections and finally coated with Tarmac, land drains being laid longitudinally along each side of the road. The clay, having worked up through the slag, had the effect of destroying the binding properties of the Tarmac, which disintegrated, and the whole construction began to collapse. A section having a gradient of 1 in 20 was taken in hand and entirely reconstructed in the following manner: The whole of the road material was removed, and the drain tiles were relaid in a trench of sufficient width and depth to allow of 6 in. of clean clinker ashes completely surrounding them. Drains were laid in herring-bone fashion across the road, and a foundation of 6 in. of hard clinker ashes was laid and consolidated and the old lump slag was then hand pitched on top of the clinker and covered with the slag rejections. After this had thoroughly consolidated, the old Tarmac was screened, relaid and tar-sprayed, the surface being finished with ¾-in. slag chippings, no new material being obtained excepting a small quantity of slag rejections. The work was completed in October, 1915, and the road is still in perfectly good condition and shows no signs of the previous trouble. An 8-ton steam roller was used on this work, and the cost was 55 ct. per sq. yd.—J. Cracroft Haller, Notts County Surveyor, in The Surveyor.

TABLE I.—HYDRAULIC SITUATION OF THE VARIOUS COUNTRIES.

Country.	Area (sq. miles).	Population (latest available figures).	B. horse-power available (1915 estimate).	B. horse-power developed (1915 estimate).	Per cent utilized.	Horse-power per sq. mile of area. Available.	Developed.
[illegible]	[illegible]	[illegible]	28,100,000	7,000,000	24.9	9.3	2.31
[illegible]	2,000,000	8,033,500	18,803,000	1,735,560	9.2	9.40	0.86
[illegible]	927,800	8,000,000	8,094,000	1,725,000	21.0	8.74	1.83
Austria Hungary	241,330	49,418,600	6,460,000	566,000	8.8	26.8	2.34
[illegible]	207,100	39,601,500	5,587,000	650,000	11.6	27.0	3.14
[illegible]	124,130	2,302,700	5,500,000	1,120,000	20.4	44.3	9.02
[illegible]	194,700	18,618,100	5,000,000	440,000	8.8	25.7	2.27
[illegible]	172,900	[illegible]	4,500,000	704,500	15.6	26.0	4.08
[illegible]	91,280	28,601,600	4,000,000	976,300	24.4	43.8	10.7
[illegible]	15,976	3,742,000	2,000,000	511,000	25.5	125.2	32.0
[illegible]	[illegible]	64,903,400	1,425,000	618,100	43.4	[illegible]	2.96
Great Britain	[illegible]	40,831,400	[illegible]‡	80,000	8.3	10.9	0.91
[illegible]	[illegible]	182,182,600	20,000,000	1,000,000	5.0	[illegible]	0.12

Canada "B" refers to the present most thickly populated portion of the Dominion.

Canada "A": 2,000,000 sq. miles taken as the area treated in the Conservation Commission's estimate of available water power, and [illegible] settled during the next few decades. This includes the area indicated by "B," and includes the 8,000,000 population of "B." The area of the whole Dominion is 3,729,750 sq. miles. The powers given are a 1917 estimate. [illegible] sq. miles). †1911 Census + 12 per cent. ‡The estimate for Great Britain is almost certainly much too high. §A recent estimate by the Ministry of Ways of Communication (Electrical Review, Feb. 22, 1918).

Road and Street Monthly Issue

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Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation and Dredging
(b) Rivers and Canals
(c) Quarries and Pits
(d) Railways, Steam and Electric
(e) Management and Office System

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials

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Volume LI. CHICAGO, ILL., MAY 7, 1919. Number 19.

The State Engineering Society as "The Guardian of the Business Interests of the Engineer"

Those that read our Foreign Engineering Review issue last week were doubtless impressed by the fact that British civil engineers are agitating co-operative effort to secure higher salaries. In England, in Canada and in America, civil engineers have evidently decided that something must be done to better their financial condition. After grumbling for a generation, engineers are apparently about to take widespread action of some sort—probably of several sorts.

In his presidential address to the Oregon Society of Engineers, J. W. Cunningham said:

"When we get away from idealism and begin to talk of such earthly things as the business interests of engineers, some will at once prick up their ears and decry 'unionism.' It is in fact unionism. The founders of the country asserted that 'in union there is strength,' and only recently have some people grown ashamed of the word. Federation of engineers to look out for their own material welfare does not however in any way involve affiliation with existing labor union organizations. While I favor the unionization of draftsmen now under way, I believe it impractical and inexpedient for engineers generally to follow the same course. An example of an organization for the business interests of its members is the 'Greater Portland Association' of the smaller retail merchants. This has never been called a union, but no union could be more active in furthering the interests of its members. Upon reflection it will be found that almost every specialized line of trade or business is represented by a militant organization willing to go the limit in protecting its own members. Even the other professions such as medicine, law, and dentistry devote their associations more to economic betterment than to educational uplift. Only in our own branch do we find a feeling among a few that collective action in matters material may deprive us of a true professional standing."

Mr. Cunningham goes on to advocate the affiliation of all the engineering societies in Oregon. But even more important is his advocacy of a new formulation of the objects of the state society, thus:

"The objects of this Society shall be to advance the practice of applied science, to cultivate a spirit of fellowship, unity and mutual support among technical men of all branches, to develop among the members a knowledge of their civic responsibilities, and to create a public appreciation of the social and economic worth of the profession."

Speaking more specifically of the proposed changes, he said:

"In the past we have made the educational fea-

28 Pages = 40 pages

The 28 pages of articles in Engineering and Contracting contain as many words as 40 pages of the size and typography commonly used by other engineering periodicals. Ours is the same size of type and type-page as that of The Literary Digest—easily read, yet giving a large volume of reading matter per page. Our 28 pages of articles would fill 112 pages of the standard 6x9 in. text-book. It would take 10 such books of 580 pages each to hold all the articles printed each year in Engineering and Contracting, to say nothing of our weekly construction news.

[illegible] [illegible]. In my [illegible] let us leave the improvement of the technical [illegible] [illegible] to the National bodies, who with [illegible] [illegible] and [illegible] publications can surpass us in every [illegible]. Let us make the Oregon Society of Engineers one of [illegible] [illegible], cooperation and material service to [illegible] [illegible]. Let us adopt a special line of work which no [illegible] [illegible] is attempting to perform, and make the Oregon Society the guardian of the business interests of the engineer . . .

"[illegible] will notice a similarity between my views and those [illegible] for the last two or three years have been advanced by the American Association of Engineers. I admit the charge. I confess the greatest admiration for the work of the Association. Over a year ago a committee of this Society looked into the question of affiliation with the American Association. Following their report the proposition was decided adversely, not by reason of any lack of sympathy between ourselves and the other organization, but because affiliation would under these existing rules, require a very large increase of our dues and the sending of the bulk of the money back to the parent Association. Whenever any scheme may be worked out by which we can affiliate and yet retain the greater portion of our income to pay local Society expenses, I shall favor such action.

"Joining our Society with the American Association of Engineers would give us the benefit of a live and readable publication, and would give us the support of a large body of engineers on national, and indirectly, on local matters. As regards the employment feature, I doubt if the Association would give us much benefit, and believe we would still have to conduct our own employment department."

Coming to the question of engineers' salaries, Mr. Cunningham said:

"Whether you use the words fees, salaries, wages, or whatever [illegible] [illegible] will agree that the engineer is underpaid, considering his responsibilities and the value of his services. How shall we go about to secure greater appreciation socially and economically? This is the kernel of the whole thing when we begin to consider the business interests of engineers. We cannot resort to strikes or other crude methods of enforcing what we see as our rights. Nevertheless, we must assert ourselves if we are to gain recognition. I personally believe that with organization and with initiation we can gain the desired ends without using other means than reasoning and diplomacy.

"Before we can begin to convince the public, we must satisfy ourselves as to what we are worth. We must establish a schedule of fees or salaries for different classes of work. Absolute standardization is impossible and undesirable, since the classes of engineering work are so many and the responsibilities and capabilities of individuals are so varied. Within limitations it is feasible to define minimum salaries for almost all branches of engineering, as was done by a recent conference in the case of the railroad engineers. The promulgation of such schedules and the active educational, argumentative, and if necessary, political* work to secure their adoption, will be one of the most important lines of work for a business organization of Engineers.

"In matters of compensation, the employed engineers should and can work in direct harmony with those who as consulting or chief engineers may be regarded as employers. The engineer-employer, unless he be exceedingly narrow, will favor adequate salaries for his subordinates, providing that he can make his own charges correspondingly adequate. There must be no ruinous cutting of fees or price competition. The majority of engineer-employers will give hearty support to a general increase of salary rates, but will ask in return a measure of corresponding support from the employe."

Note particularly that Mr. Cunningham favors: (1) An affiliation of engineering societies; (2) making the state society "the guardian of the business interests of the engineer," leaving technical papers to the national engineering societies; and (3) recognition of the right of draftsmen to join labor unions.

We find ourselves entirely in accord with such a policy for state engineering societies, provided that local sections of the "four founder societies" make it their function to discuss technical problems and assist in the continuous education of their members. Specialization of function and co-operation for common ends are as desirable among engineering societies as among other organizations.

How Would You Like to Be Interned with Other American Engineers in France?

In another column a letter from one of our readers indicates that many American highway engineers are being detained in France. One engineering society has passed resolutions urging the speedy return of all highway engineers, but, as we have often said, something more than "resolutions" is needed to secure action in cases like this.

The Engineering Council and the American Association of Engineers should send representatives to Washington, D. C., to convince Government officials that American highway engineers should not be detained longer in France. This is not a matter of letter writing but for tongue talking. It should not call forth merely an occasional protest, but a continuous urging.

Read the letter from your brother engineer in France and get back of a vigorous movement to release all such engineers from their present toils.

Bituminous Carpets on Concrete Roads

Thin bituminous carpets are not now ordinarily laid on new concrete roads. Where such carpets are used at all, the common practice is not to lay them until the concrete surface has been subjected to considerable wear. Bituminous surfaces stick better to warm concrete than to new concrete. But the main reason for postponing the application of a bituminous carpet is to secure the maximum amount of wear from the concrete surface before covering it with a bituminous wearing coat.

It is still a debated question whether a thin bituminous carpet should be laid at all on concrete. If it is thin it does not serve to distribute the wheel load over the concrete; hence a stronger concrete is needed than where a fairly thick asphalt is used. A thin bituminous carpet on a lean concrete base is undoubtedly an economic mistake. But if a lean concrete is used, should not a fairly thick asphalt wearing coat be applied at once without waiting for the concrete to wear? Lean concrete is apt to wear very unevenly, resulting in a wavy or pitted surface that is not a very satisfactory base for an asphalt pavement.

Seven years ago New York State built 300 miles of lean (1:2.5:5) concrete roads having a thin bituminous surface. This form of pavement immediately began to prove unsatisfactory. Then a rich (1:1.5:3) concrete pavement without a bituminous surface was adopted. After four seasons of wear this rich concrete requires no carpeting.

Utilizing Old Macadam as a Base for Pavements

There is a large mileage of old macadam that must either be used as a base for new pavements or removed entirely. Before selecting the second alternative the engineer should study the economic problem carefully. The fact that the macadam is badly rutted is apt to lead to its hasty condemnation, especially by an engineer who has had little or no personal experience in resurfacing macadam.

Old macadam can be very cheaply resurfaced provided it is loosened by a scarifier and spread by a heavy harrow, as described in Gillette's Handbook of Cost Data. A steam roller will daily consolidate two or three times as many square yards of old macadam as of new macadam. This is largely due to the fact that most of the work of rolling new macadam consists in compacting the earth subgrade and the lower layers of stone.

Having resurfaced the old macadam a wearing coat of any desired kind may be laid upon it, provided the resulting pavement is thick enough to carry the heaviest wheel load. Asphalt, bitulithic pavement, brick concrete etc., have all been used successfully as wearing coats on an old macadam base.

George C. Warren states that he has "proved by long experience that old macadam forms a most superior foundation for a resilient and stable bituminous wearing surface." He cites a bitulithic pavement laid in 1903 on an old macadam base on Dartmouth St., Boston. Mr. Warren advises widening macadam with concrete shoulders, where the old roadway is too narrow.

How Can the Public Be Taught to Appreciate Engineering Services?

One of the great problems confronting civil engineers is the problem of educating the public to the real value of engineering knowledge. In speaking of the "public" we do not confine the term to the "average citizen"; we include those that are far above the average—the business man, the political leaders, the editors of daily papers. So great is this educational problem that it might well constitute the sole function of local engineering societies.

George A. Carpenter, city engineer of Pawtucket, R. I., recently said:

"Our municipalities, in general, regard engineering services so lightly, from a financial point of view, that there is very little encouragement for a young man to stay in this line of engineering work. It is a great pity, too, because municipal engineering offers such a variety of interesting problems that it should be made financially attractive to capable men. It is a very short-sighted policy, in my opinion, for a city to train engineers in its particular problems and then, when such engineers are in a position to render the very best services to the city, cause these engineers to become dissatisfied with their positions and seek other fields of labor because of insufficient compensation. At the present time our young engineers are comparing their compensations with those of the carpenter, bricklayer, plumber and even the day laborer, and are finding very little encouragement to remain in a profession where education and mental capacity seem to count for so little."

Of course it is pure ignorance that prevents the public from paying satisfactory salaries to municipal, county, state and federal government engineers. Dismayed at the density of this ignorancy, and disheartened by the enormity of public mental inertia, hundreds of civil engineers annually leave public employ forever. Other fields benefit by this continuous influx of engineering talent, but at the expense of public works. Every civil engineer knows this—has known it for years. Yet, collectively engineers have done next to nothing toward remedying the condition.

Unless we mistake the signs engineers are about to engage in a great campaign of education, with the public for pupils and the worth of applied science as their text. In short, engineers are about to use the force of publicity as a means of creating a powerful demand for engineering services. Publicity is a force little understood by engineers. In fact engineers have usually shunned it as being an "unprofessional" force. But having failed to secure desired results without publicity, engineers are about to try its efficacy.

Draftsmen's Unions

Draftsmen in many cities have joined the American Federation of Labor. This step is so novel that many civil engineers regard it with doubt if not with actual disfavor. We look to see the unionizing of draftsmen spread rapidly throughout the country. Nor are we antagonistic to such a movement. May it not eventually inject into labor unionism a new leaven that will improve the economic policies of organized labor?

Many draftsmen are technical graduates, and among them are men sufficiently well trained in economics to know that certain labor union policies are uneconomic. For example, the policy of demanding uniform pay for all workers of a given class, regardless of individual merit, is a pernicious policy. If men who have had a training in economics, but are not members of labor unions, undertake to show unionists that the uniform pay policy is uneconomic, little heed is given to the demonstration. All that they say is regarded as biased. But if the same economists were themselves unionists, their teaching would at least not fall on deaf ears.

Engineers have invaded many fields and have become members of many organizations of men, always with profit to those with whom they have come to associate. Hence it may not be entirely visionary to express a belief that when engineers become members of labor unions, they will also become leaders, and as leaders they will help to eliminate many of the bad economic policies of the unions.

Don't Forget to Boost for "Sleepy Hollow Pike"

In the effort to induce the federal government to make large appropriations for roads, there is danger of neglecting to persuade the counties to be equally liberal. Moreover it should be remembered that the inertia of the federal government is far greater than that of all the counties combined. This arises partly from the fact that congressmen are still skeptical as to the propriety of large federal appropriations for roads, and partly from the fact that small political units, like counties, are always more easy to educate than larger units.

Finally, sight should not be lost of the fact that most of the road mileage will always remain of local importance only. It is well to "boost" for the Lincoln and Dixie highways. It is equally well—and much more apt to bring quick results— to "boost" for the "old ridge road" or "the Sleepy Hollow pike."

American Highway Engineers in France

To the Editor: I just read an article in the Engineering News-Record of March 6 which has caused no little interest here, headed "Highway Builders in A. E. F. Needed Here." Am enclosing a copy of the letter I am writing to the editor.

As your paper was a thorough and consistent advertiser of the Road Battalions (speaking especially for the 43d Road and Bridge Battalion) and endeavored to stimulate the enlistment of road men of education, experience and ability I believe that you may be interested in the work now being done by them—hence this letter.

Have also noted the action taken by the American Road Builders' Association and will say that the resolution has caused a sigh of relief to go up from those road men who have been attached to the foresters. They have felt that all identity is lost; that the foresters look upon the road men as a southern farmer looks upon the Negro; that they would be compelled to stay here until the last of the foresters had gone home and until all of the forestry operations had been cleaned up by themselves and done in accordance with the wish of the French.

University graduates, experienced engineers, contractors, grader men, etc., do not relish the idea of chopping burned brush and timber and piling faggots over here while the highway work at home gets organized and proceeds without them. The losses in this case are two-fold. First, the economic loss wherein a high-priced man is kept at day labor and the financial loss and consequent distress caused to the soldier and his family by being forced to work at soldier's pay instead of receiving pay commensurate with his ability and training on his work. Also you can readily appreciate the state of mind which these men are in constantly. To appreciate the mental condition that these men are in, it is only necessary to picture engineers and contractors of your acquaintance in these soldiers' position.

It is therefore with the most eagerness that the article mentioned and such resolutions as passed by the American Road Builders' Association, are grasped by the personnel of the 48th Company, 20th Engineers.

Surety Bonds and Contractors

To the Editor: I have read with a great deal of interest the editorial appearing in issue of April 2, "What Can Be Done to Protect Contractors from Ignorant, Cut-Throat Competition?"

Personally, I do not think too much space can be devoted by engineering and contracting journals to the subject of the responsibility and reliability of contractors who engage in public work.

I fully agree with you that the public works contractor should not be permitted to furnish a bond other than the bond of a satisfactory bonding company, but I should like to have you explain just what you mean by the term, "Satisfactory Bonding Company." In those states where, by law, the con-

[illegible] surety company bond or other [illegible] awarded in the last [illegible] ability and financial standing of the [illegible] that of the contractor [illegible] experience however, we [illegible] to get a surety company [illegible] of the contractor even though [illegible] with a capital running into millions, and cash reserves in many states, as it is [illegible] contractor.

[illegible] all bonding companies, no matter what may be the terms of their bond, to either attempt to force the municipalities and the creditors of the defaulting contractor, including the laborers and material men, to compromise their claims for from 75c to 50c on the dollar, or to compel them to bring suit and secure a judgment [illegible] make proper settlement.

[illegible] do you not agree with me that it is the duty of the engineer in charge, or [illegible] to see that not only is the contractor financially responsible, reliable and experienced, but that the company who furnishes his bond is [illegible] and has the further important qualification of bearing the reputation for promptly discharging its obligations, voluntarily assumed for an adequate consideration, without forcing the obligees, at the expense of time and money, to get their claims adjudicated before settlement [illegible]

G. H. TEFFT,
Secretary, General Manager,
Clay Products Association.

Chicago, Ill.

[A "[illegible] bonding company" is one that not only has ample capital but a record of fairness in settling claims against it. Unfortunately too many bonding companies are given to fighting nearly every claim. If state, county and municipal officials would periodically confer with one another, and would blacklist all bonding companies that are unfair, we believe that an end could be brought to the practice that our correspondent complains about. Yes, it is the duty of public officials not only to select reliable contractors but to select also reliable bonding companies.—Editor.]

Crushing Field Stone for Road Work

Field stone is usually collected for crushing. This preliminary work, stated Wm. Huber in an address at the last annual convention of the Ontario Road Superintendents, can usually be done most cheaply in the winter, as hauling can be more easily carried out, with bigger loads and more men are available. The use of field stone has the advantage that material can be delivered right at the road. It is advisable to have it placed at reasonably short intervals, in order that subsequent hauling may be reduced to a minimum. The quantity should therefore be estimated and placed at, say, intervals of a mile, the maximum haul being thus limited to half a mile.

One arrangement for crushing is to pile up the stone in rows about 8 ft. apart, leaving just room enough for the crusher to pass between. The objection is that the stone is carried piece by piece by man power to the crusher, and the cost of labor is bound to be excessive. Another point is that, while the crusher is theoretically supposed to be kept moving down the row, it is not moved at very frequent intervals.

The better plan is to pile the stone in one large block, and handle it the same way as from a quarry. In crushing field stone, there is the problem of handling stones larger than the capacity of the crusher. One case was mentioned in which contractors were given a stone fence, free, for road purposes. Many of the stones, however, were too big for the crusher, and they had to use the "bull-dozing" method to break them, but in the end they found it cheaper to obtain their stone from a limestone quarry.

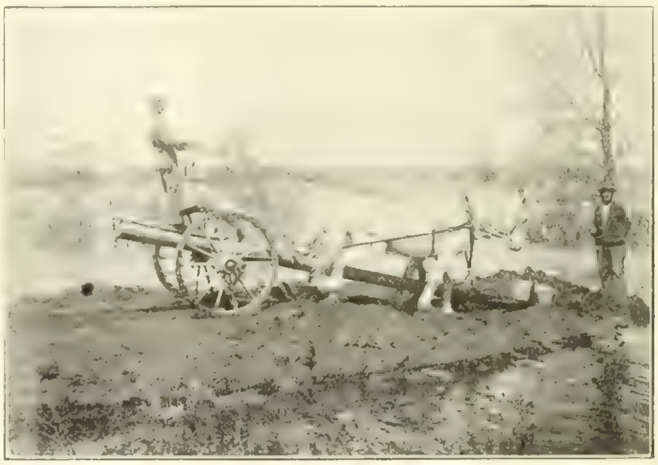
In the "bull-dozing" about a third of a stick of dynamite is placed on top of the stone and tamped with clay and then fired. The stones are not, as a rule, shattered, but can afterwards be easily broken with a hammer. Sometimes a small hole is drilled in the top of the stone and the charge placed in it, and perhaps this is the best way.

Methods of Grading for Roads Across Sloughs

By L. I. MARTIN.

During the past 5 years it has been the writer's task to grade across a large number of pot holes, sloughs and peat bogs, over which it was impossible to drive teams. These have varied from a few feet in length to a length of 3,000 ft. in one extreme case. During this work the writer has made some deductions as to costs and methods that may be of interest to contractors and engineers.

The most common method of procedure is by what is termed bull-dosing or pushing the grade. This method is particularly adapted to sloughs containing standing water and to short stretches of bog. The grade for this work should be carried from 40 to 60 ft. wide at the base; or in the case of standing water to a minimum width of 40 to 45 ft. at the water level. Wagons or scrapers are dumped as close to the edge as it is possible to drive the teams and the dirt is then pushed ahead by the bulldoser, as shown in the illustration. A good operator on the bulldoser can handle the dirt from 5 to 6 teams on an average haul of 500 ft., and more as the length of haul increases. With a good operator little time is lost over a straight haul on good ground. The outfit shown was pushing for five No. 2 wheelers (15 cu. ft.) on a 400-ft. haul. A heavy steady team is required to handle this pusher. The actual cost per yard over straight haul dirt with a good operator should not exceed 2 ct. per yard, and may even run below this. Unless dirt can be sent both ways from the cut, however, or the fill is long enough to use the full outfit, an elevating grader is not worked at full capacity and the extra cost per yard on this account will be raised to perhaps 6 ct. additional as a maximum.



Pushing the Grade With a Bulldoser.

The outfit shown in the picture was a home-made affair consisting of the front wheels of a dump wagon, a straight telephone pole 8 in. at the butt and 20 ft. long, and a push board braced as shown, shod with a 3-in. by ⅛-in. iron edge on the bottom. It was so made that the pole with board attached could be removed in a few minutes from the wheels and loaded on a wagon. These outfits can, however, be bought from any road machinery firm. This method is much superior and cheaper than the old one of having shovelers at the end of the grade pushing the dirt off with a shovel.

Another method we have used in timbered country, is to cover the ground with a brush mat, covered with straw and in the worst spots with corduroy of poles. This requires considerable hand work and always leaves a chance for a horse to step through, causing loss of time and sometimes injury to the animal. It is of little use except on short pot holes.

The most successful method both from a cost basis and construction basis was tried on a grade about 1,300 ft. long. It was determined in the fall preceding the work to straighten this road to avoid a number of dangerous curves and shorten it about ½ mile. To do this we were compelled to cross a peat bog 1,300 ft. in extent.

In the spring just as soon as the snow was off but before the frost was out three teams were hired to haul straw over the bog on the line of the work. This was placed to a depth of 18 in. and a width of 40 ft. The bog had a natural growth of heavy grass. As the ground was still frozen no trouble was encountered in driving over the bog except that due to the natural roughness of the ground. The idea was that the straw would not let the frost out from under it until long after the cut was thawed out sufficient to work in. We started grading about May 10 on this work and had no difficulty in driving back and forth across the straw. The bottom of the grade was carried across first and later raised to the desired height. The frost did not go out from under the grade till in July at which time it was necessary to place a grader and planer on the grade for about two days to keep it smooth and even. The total additional cost of this work did not exceed $100 of which $50 was the cost of hauling the straw, $15 the cost of the old straw stack and $35 the cost of planing and grading during the time the frost was going out.

The most peculiar slough we have ever graded across lay on a state road. This slough is 3,000 ft. across and at 600 ft. from its north edge a creek runs through it. On both sides the ground rises abruptly on about a 15 per cent grade. Our grade line on the road is 5 per cent on the north side and 8 per cent on the south side at which place there is a 25-ft. cut. Soundings for a bridge were taken in the fall across the creek and at 6 ft. under the peat the auger encountered a heavy clay containing some rock.

There was at this time about 2 ft. of water over the entire bottom, but in a distance of 2,000 ft. below the slough where the stream cut through between the hills we had a fall of 6 ft. A plow ditching machine was first run down the stream bed and the water was lowered about 3 ft. by this method, leaving the creek about 1 ft. below the bank. The plow was then run through the slough on both sides of the road at 25 ft. on each side of the center with the object of providing a good ditch and of throwing up some dirt in the center. This ditch was 3 ft. deep and 18 in. wide in the bottom. There was a fall from both sides to the creek of about 2 ft. so the ditches were kept washed clean by streams of water from springs on both banks. The grade was now bulldosed across from the south side as far as the creek and a crew put to work to excavate for the bridge. This excavation was made and good clay footing was apparently encountered at 6 ft. below the peat. Forms for one footing were put in and concrete was about to be poured when suddenly the bottom broke upward and we discovered we were on a false bottom. Soundings were then made to find the real bottom and 60 ft. of rod was put down without encountering anything but muck and marl. Soundings across the entire slough were then made and the same conditions were found to exist clear across. At from 4 ft. to 6 ft. clay was encountered from 2 to 4 ft. thick and below this no bottom could be reached. The space for the bridge was then filled with brush and poles to give a bearing and into the space two corrugated culverts were placed and covered. The grade has been in use for 4 years now and has never shown any signs of settling though under considerable heavy traffic such as threshing outfits. The result of this was that ever since we have taken no chances on our soundings and have twice since encountered similar conditions of false bottoms under sloughs.

Finishing 1-course Sidewalks with Paving Roller.—A paving roller was used for finishing 1-course sidewalks constructed recently in a subdivision at Beloit, Wis. The walks consisted of slabs about 30 ft. long, 4 in. thick with ¼-in. joint filler every 30 ft. Joints were defined on the surface in the usual manner for the sake of appearance. Coarse aggregate in this work ranged from ¼ in. to 2 in. An attempt was made to use the regular paving roller but was unsuccessful because the walks were only 4 ft. wide. This difficulty was solved by building a roller 2½ ft. long and 11 in. in diameter, which forced the particles of large aggregate away from the surface and brought ½ in. of mortar to the top for final finishing. Instead of striking the concrete off even with the side forms, the strikeboard was raised about ¼ in. by nailing strips on its edges and the contour of the walk left slightly above the forms and later brought even with them by rolling. Labor cost of placing this walk proved to be less than for a 2-course walk, states the Concrete Highway Magazine, because the usual methods of construction were considerably simplified by this practice.

New Requirements in Illinois Specifications for Concrete Roads

The 1919 specifications of the Illinois Division of Highways contains a number of new provisions for the construction of state and concrete roads. Chief of these are the requirements for subgrading, for consistency of concrete and for placing concrete pavement. The requirements concerning subgrading for concrete base and pavement are:

"The rolling and thorough compaction of the subgrade shall extend for a width of at least 12 in. beyond the edges of the proposed base course or pavement; no back fill of any material excepting concrete will be permitted without re-rolling.

"Immediately before any concrete is placed upon the subgrade it shall be tested for elevation by the use of a templet, furnished by the contractor, riding on the side forms behind the mixer. In the lower edge of the templet there shall be driven nails 6 in. apart and to such depths that their heads will just come to the true position of the subgrade when the templet is riding on the forms. Testing the elevation of the subgrade shall be done by moving the templet back and forth on the forms. On those areas of the subgrade found to be too high by as much as ⅛ in., additional excavation shall be made until the required depth is reached and the excavated material shall be deposited on the shoulders. Those areas below the true elevation shall be filled with concrete making an integral part of the slab proper, all expense for this extra concrete including both labor and material being borne by the contractor.

"Hauling by teams, trucks or otherwise over the finally completed subgrade for a distance of more than 500 ft. will not be permitted. If hauling over the subgrade for such distance results in ruts or other objectionable irregularities, the contractor shall re-roll the subgrade before materials are deposited upon it.

"The subgrade shall be clear of all materials that may have fallen upon it and if dry it shall be thoroughly wetted immediately before the concrete is placed but not to the extent of forming mud or pools of water."

Regarding consistency of concrete the specifications state:

"There shall be used such an amount of water that the consistency of all the batches of concrete will be the same, the amount of water for each batch being carefully measured. The amount of water used for each batch shall be such that a conical pile of the concrete having a 45° slope will neither tend to flatten nor to run at the edges. The consistency shall be such that the concrete will require considerable tamping. There will not be tolerated a consistency that would tend to separate the fine particles from the coarse.

"The consistency of the concrete shall be determined by the following test: A cylinder 6 in. in diameter and 12 in. in length shall be filled with concrete which shall be tamped until all voids are filled and a slight film of mortar appears on the surface. The cylinder shall then be removed and the vertical settlement or "slump" of the concrete noted. This settlement shall not exceed 2 in. when the mechanical finishing machine is to be used and shall not exceed 4 in. when the finishing is to be done by other methods permitted in the specifications."

The requirements regarding placing and tamping the pavement are:

"The concrete shall be placed between the side forms to the full thickness of the pavement and in successive batches for the entire width. After the concrete has been deposited it shall be leveled off and tamped mechanically with a machine approved by the engineer, until all voids are removed and the concrete is thoroughly compacted. The mechanical tamper shall go over each area of the pavement at least five (5) times and at such intervals as will give the desired results.

"The finished pavement shall be uniform in character, free from voids and depressions and true to the cross-section shown on the plans. Portions of the pavement showing voids in the concrete after finishing and removal of the side forms shall be rejected.

"Hand tamping and finishing may be substituted for the mechanical, providing that at least 4 men are engaged at the exclusive work of tamping the concrete. If hand tamping is used, the tamper shall meet with the approval of the engineer."

City Recording System for Real Estate Titles

[illegible] system for the registry of real estate has been devised for the city of New Castle, Pa., by the City Engineer, [illegible]. The plan was worked out to comply with the laws of Pennsylvania which provide that [illegible] of the third class shall keep records of titles of the real estate within their boundaries.

[illegible] was made of all [illegible] and stone monuments [illegible] every parcel at each [illegible]. These monuments are [illegible].

The plans were made on [illegible] paper at a scale of [illegible]. Each [illegible] and numbered [illegible] to cover the territory embraced [illegible] center of street by red [illegible] in red. Stone [illegible] street lines, lot lines and lot distances are shown in black. If the lot is in a [illegible] plan [illegible] number is shown, it is [illegible]. Each section has its lot numbers running from 1 to [illegible] are shown in red figures. The plan also shows in yellow figures, the registry book and page where the lot is recorded. Thus 2/25 shows that the lot is recorded in book 2, on page 25.

[illegible] are not shown to or handled by the public in general, but tracings have been made upon which is also shown the name of owner in black. When there is a transfer of ownership, the name is changed.

When a deed is presented, Form 1 is used to give the owner a receipt. These receipts are in book form with 200 pages. At later date when this receipt is presented, the deed is returned, upon the signature of the owner.

Form 2 is used for entering deeds. This form is in a book of 200 pages.

Form 3 is a registry book of 600 pages and allows for 14 transfers for each lot, before a new entry may be made.

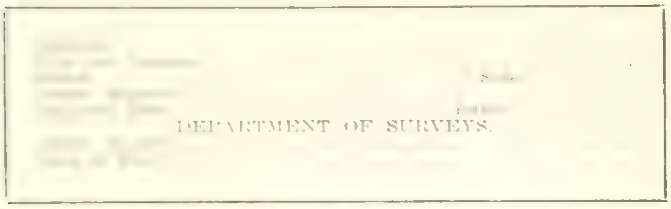
Form 4 is used for the description of the deed. These are kept in a steel filing case with 100 files, one file for each plan section. The description is folded and stamped on back and placed in numeral order in file.

The notation shown in Form 5 is stamped on the original deed before it leaves the office.

This system of registry may be kept in compact form by having a combination plan case and book rack. The plans and tracings are kept in 10 drawers, 10 sections to each drawer. Registry books are kept opposite drawers.

The steel filing case for lot descriptions is in two sections of 50 files each.

After the installation of this system in New Castle one registry superintendent has been employed, who attends to the details of the system, furnishes copy of transfers to city assessors, and marks it on their plans. This same man also acts as clerk in the engineering office, issues street permits, shows plans when requested, etc.

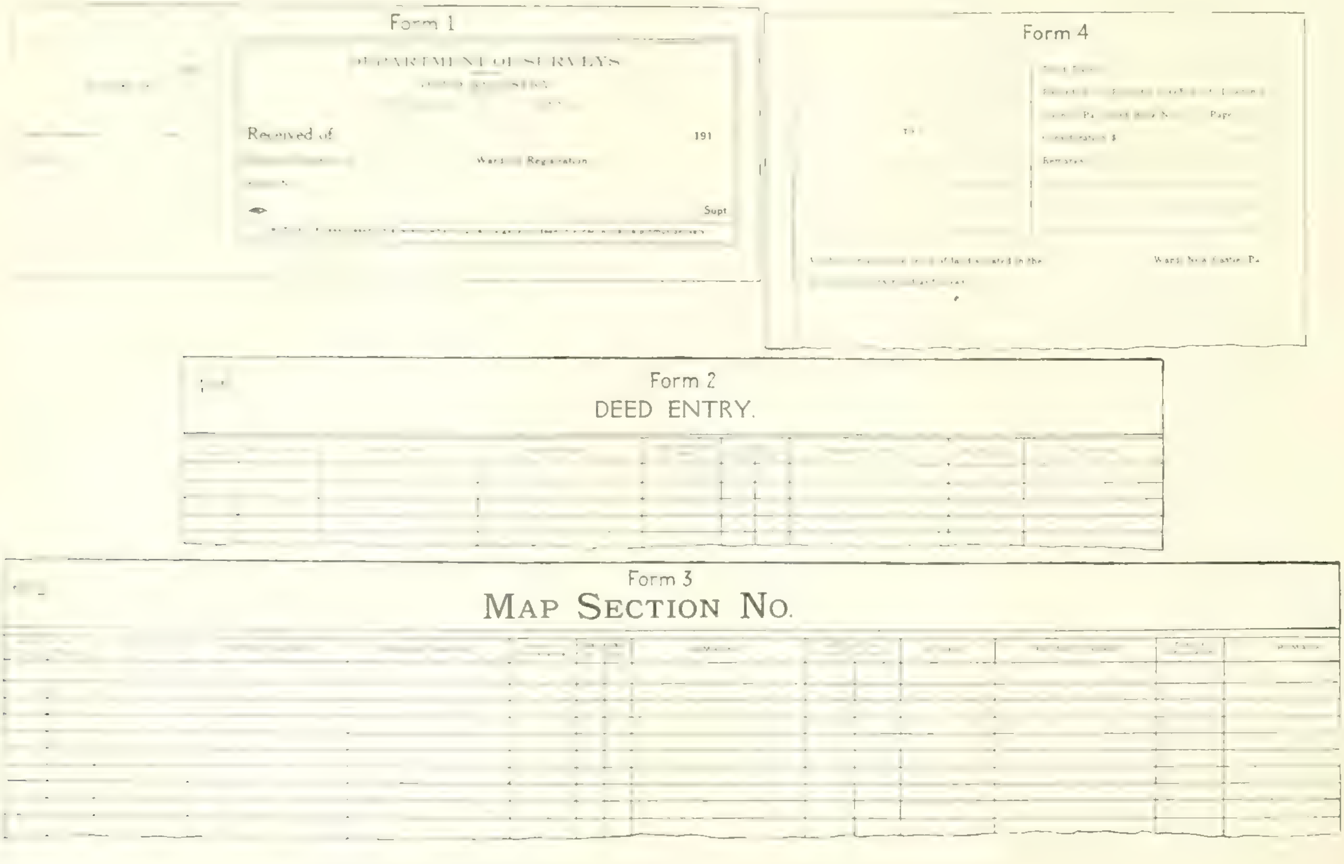


DEPARTMENT OF SURVEYS.

Form 5

Finishing Concrete Pavement with Board Float.—A float consisting of a 1½ in. x 8 in. seasoned board with the edges slightly rounded, and about 1 ft. longer than the pavement width was used in finishing 15,000 sq. yd. of concrete pavement on a road near Houston, Tex. The board was provided at each end with handles like those on a plow and by means of which the finishers operate it in a manner similar to operating the belt. The laborers preferred the board float to the belt, because there was less back-bending and they regarded the work as easier. Writing in the Concrete Highway Magazine, Mr. W. L. Love, office engineer of Howe & Wise, the engineers for the work, states that the results secured by this were better than by any other method they had tried and that they intended to specify the wide board floats in future work.

Sidewalks for Rural Roads.—The Kansas Senate has passed the House bill, which provides for the construction of sidewalks along the public highways upon a petition of 50 per cent of the property owners.



Form 1

DEPARTMENT OF SURVEYS

Received of 191

Ward Registration

Supt

Form 4

Page

Remarks

Ward, New Castle, Pa.

Form 2

DEED ENTRY.

Form 3

MAP SECTION NO.

Forms Used by City of New Castle, Pa., for Registry of Real Estate.

General Features of Brick Pavement Construction

An interesting discussion of brick pavement construction is given by A. T. Goldbeck, Engineer of Tests, and F. H. Jackson, Assistant Testing Engineer of the U. S. Bureau of Public Roads, in a report printed in Public Roads, the official publication of the Bureau. Their conclusions are based upon observations made during a recent inspection trip of a large number of brick roads in the Middle West, as well as upon the experiences of engineers and contractors who have done a great deal of work along this line. The matter following is abstracted from Public Roads:

Type of Foundation or Subgrade.—In a very large number of the roads inspected there were to be observed many evidences of foundation or subgrade failures. A great many longitudinal cracks were observed, and these occurred on fills where there was apparently good drainage as well as in localities where the drainage was obviously bad. The character of the soil seemed to play a very important part in influencing the number of longitudinal cracks, and it was very evident that sticky, clay soils that would retain a large amount of moisture and undoubtedly show considerable heaving during freezing and thawing weather were much more likely to produce longitudinal cracks than were the more porous, sandy soils. Specific instances of brick pavements in the city of Conneaut, O., some laid on a sandy foundation, and others on a clay foundation, may be cited. Those on the clay foundation cracked and heaved, those in the sandy part of the town remained intact. Throughout the sections visited the same general condition existed.

It can not be too strongly urged that a thorough study must be made of the underlying soil and the drainage conditions before attempting to design a road for a particular locality. It should be noted also that certain kinds of soils are not susceptible of drainage by the methods ordinarily practiced, using tile drains and French drains along the side of the road. It is apparent that capillarity plays a very strong part in influencing the retention of moisture by the subgrade, even though apparently good drainage facilities are provided. A thorough study of capillarity and methods of draining various kinds of soils would be of great benefit.

Instances have been cited, notably in the Cleveland-Akron road, in which the superimposed loads were such that the subgrade, softened by the presence of moisture, readily gave way and was unable to support the slab which, in turn, did not possess sufficient strength to act as a beam but was broken through in spots. It is possible that soils of this character could be improved very greatly in their bearing value by the use of a porous filling material, such as cinders, broken stone, slag, or gravel, and in this way the high-unit pressures transmitted directly through a pavement would be so distributed that the unit pressure on the natural soil foundation would be within the bearing value of the soil. It is also possible that correct methods of drainage might accomplish the same end; that is, increase the bearing value of the soil by drying it out.

It has been suggested that as an aid to such drainage measures a treatment of bituminous material might be beneficial. An instance of the value of a filling of porous material and of good drainage may be noted in the case of Goodfellow Ave. in St. Louis, where telford drains were placed at the side of the road and a subbase of cinders used under the broken stone wearing surface. There are no instances of foundation failures in this road, although it carries considerable traffic. It has been suggested that a good method of increasing the bearing value of the soil is to provide blind drains along the sides of the road with frequent outlets, so that the water table will be lowered considerably below the wearing course, notwithstanding the effects of capillarity.

Type of Base.—The object of the base of a brick pavement is so to properly support the wearing surface that it will maintain its original contour and not become depressed in spots or wavy. It is perfectly obvious that the character of the subsoil, which supports the foundation, and the character of the loading transmitted through the wearing course to the foundation, should control this design. Thus, one would not expect that there would be a necessity for a heavy concrete foundation if the subbase were always exceedingly firm and unyielding. On the other hand, if the subgrade were exceedingly soft, such as obtains in clay saturated with moisture, a thick base is obviously necessary in order to properly distribute heavy loads to the subgrade and reduce the unit pressure within the bearing value of the subgrade.

From these considerations it should be plain that it is perfectly possible that a wearing surface of brick laid directly on the soil might remain in very good condition if the traffic is not very heavy and if the subbase is well drained and therefore firm and unyielding under all conditions. Instances of such construction have been noted, such in Cleveland, O., and Sterling, Ill., and other cases of an exceedingly light concrete base from 1 to 2 in. thick have been noted at Danville and North Alton, Ill. In a number of instances the brick surfacing has been laid on a rolled slag or a rolled stone foundation and has proven to be highly satisfactory.

The object lesson furnished by these roads is that the character and thickness of the base should be very largely governed by the local soil and traffic conditions. It should be emphasized very strongly that it can not be considered good practice to make a standard design for a brick road and apply this design to all sections of the country irrespective of these local conditions.

It is the practice in various sections of the country to build a brick wearing surface upon an old macadam road used as a foundation, and in a number of instances the brick wearing surface is wider than the old macadam road. Failures of the brick surface laid upon such roads have been noted, such, for instances, as occurred at Dixon, Ill., in which the sides of the brick road settled in spots due to the settlement of the new macadam foundation. Had the macadam foundation settled uniformly, trouble of this character could have been avoided, so that, unless the macadam is given uniform compaction, it is to be expected that future settlement will be unequal.

It is the opinion of the authors that when an old macadam road is used as a foundation it is advisable to plow up the old surface and reroll it as evenly as possible, especially when the new surface is wider than the old. This applies particularly to an old road surface which is badly rutted and pitted or the crown of which must be changed to make it suitable for the brick wearing course. In some cases it might be economical to resurface the old macadam with a cement-sand bedding course, making it no thicker than is necessary to produce the proper crown. Attention has been callen to the use of an old brick pavement as a foundation course for new wearing surface. Such practice seems to have worked out very successfully when a cement-sand bed was used, as evidenced by the roads at Danville, Ill.

Thickness of Concrete Base.—Since the foundation plays the part of distributing the load to the subbase, it is obvious that where the subbase is soft and the traffic heavy, the greatest possible distribution of load must be obtained, and this can be accomplished best by the use of a concrete base, since its resistance to bending aids in distributing the load. The proper thickness of a concrete base has been a mooted question. At the present time a determination of the proper thickness of concrete base for different types of brick roads must be based on precedent. It would seem from the results of observations that the present-day heavy traffic can be carried safely on a 4-in. concrete base with 4-in. brick wearing course when monolithic construction is used, and when the sub-grade conditions are favorable. It would seem highly desirable that the thickness of this base be increased along any stretches of the road in which the subbase conditions might be open to question. On very heavily traveled city streets the thickness of the concrete base will likewise have to be increased.

Where a sand-cement cushion is used, although it is not believed that such construction is a true monolith, a 4-in. concrete base should prove sufficient under heavy traffic, provided this base is increased in thickness over bad spots in the subgrade. When sand-cushion construction is used with a grouted brick surface, a 6-in. concrete base should give good results under heavy traffic, with an increase in thickness over the soft spots in the subgrade. If a bituminous filler is used in the brick-wearing surface, theoretically the concrete base should be thicker than in the case of a grounted surface. In the absence of test data, however, it is impossible to state how much thicker.

Cushion or Bedding Course.—In the old standard type of construction a cushion of sand or other fine material up to 2 in. thick was advocated, the idea of this cushion being to permit laying the brick to a smooth surface and also to give a cushioning effect for the traffic. When sand is used as a [illegible] surface by rolling and [illegible] rolled down with a [illegible] rolling in a number of instances [illegible] up into the joints between the brick [illegible] would be ex[illegible] with sand. In a number of [illegible] this has had a very detrimental effect in that when expansion takes place in the [illegible] compressive stress is [illegible] results in buckling [illegible] the cracking of [illegible] defect in sand cushion construction with cement grout-filled brick.

It [illegible] its way down through any cracks in the brick to the underlying sand cushion, and the amount of moisture in all probability is very much larger in the vicinity of transverse and longitudinal cracks in the brick surface than under that part of the pavement which has remained intact. Sand has the well-known [illegible] as high as about 10 per cent of moisture, and due to this action there is a probability that the brick surface is caused to bear unequally on the sand cushion unless the sand cushion is caused to [illegible] these parts of the sand cushion containing the greatest amount of moisture the expansion due to freezing will be greatest. Then, too, under the vibration of traffic and the movements of the concrete base and brick surfacing, due to expansion and contraction, the sand cushion undoubtedly is cuased to shift its position.

The washing away of the sand cushion from under the brick, leaving it unsupported, is not an infrequent occurrence. The possible cushioning effect of the sand cushion becomes of minor importance in view of its many disadvantages in other respects.

Development of Monolithic Type.—In order to eliminate some of the bad features of sand cushion construction, a semi-monolithic or cement-sand bed construction was introduced. In this type of pavement a mixture is made of about 4 parts of damp sand to 1 part of Portland cement, and this is used in place of the plain sand cushion, the brick being placed and rolled on this as on the old standard type of construction. After the brick are rolled they are wet down so that water will impregnate the sand-cement bed thoroughly, thus causing it to harden. Such construction provides most of the advantages of the sand cushion type with none of its disadvantages. It permits the brick to be brought to a smooth surface without the danger that the cushion will shift its position or come up between the joints during rolling. Moreover, there is a considerable bond between the brick surface and the concrete base, at least so far as shearing is concerned, and a stronger pavement is the result.

A further development in the monolithic type of construction has been adopted, in which the cushion or bedding course is omitted altogether. In this type of construction the brick are laid directly on the green concrete and rolled to a smooth surface. Portland cement grout then is applied preferably before the concrete base has set up. In this way a considerable adhesion is developed between the brick and the concrete base. There has been some question regarding the efficiency of this adhesion and particular pains were taken during the present inspection to gain evidence on this point. A number of pavements were examined at the sides in order to see if there was any evidence of separation between the brick and the concrete, and in no case could such evidence be found. This would seem to indicate that such construction usually is really "monolithic."

In conversation with several engineers having considerable experience with this type of construction, conflicting opinions were obtained. In general, however, it can be said that a considerable bond does exist between the brick and the concrete, provided the grouting immediately follows the laying of the brick. It is the opinion of the authors that a more truly monolithic construction is obtained when the concrete base is tamped so as to bring a thin coat of mortar to the surface and the brick laid in this mortar bed. It is believed that this flush coat or mortar works its way up into the vertical joints between the bricks and thus adds greatly to the horizontal shearing strength between the brick and the concrete. At this plane, or in its vicinity, the horizontal shear is greatest.

It often has been questioned whether or not the original bond between the brick and the concrete will be retained after several years of traffic. It has been stated that the vibration due to traffic and unequal expansion of brick and concrete will tend to loosen the bond, and in this way the supporting power of the original monolithic slab will be no greater than that of the two separate slabs of concrete and brick. This would seem to be an argument in favor of increasing the bond between the concrete base and the brick just as much as possible.

Type of Brick.—Until the year 1911, practically the only type of paving brick in use in this country was the so-called standard repressed brick with lugs molded on one side and the edges rounded. It was claimed originally that the appearance and shape of a brick were not only improved, but the density and strength were likewise increased in the process of repressing. In 1910 a type of brick was introduced in which the lugs were wire cut on the sides and repressing was omitted, the brick going directly from the wire cutter to the drying ovens. Inasmuch as the repressing was omitted, the edges of the wire-cut lug brick were square instead of rounded.

A recent development in the type of brick used is the so-called vertical fiber lug brick which differs from the older wire-cut lug type in that the brick are laid in the pavement with the wire-cut surface up instead of on the side. The lug on the vertical fiber brick is produced in the process of forcing the clay through the die, the upper side of which is cut in the shape of the lug desired. This forms what is known as a "bar" lug. It is usually about 1 in. wide and there are ordinarily four lugs on each brick.

Since wire-cut lug brick were first introduced they have gained greatly in popularity, especially when used in conjunction with a cement grout filler. Many manufacturers, as well as engineers, have reached the conclusion that the process of repressing adds nothing to the strength or density of a paving brick. The rounded edge of the repressed brick furthermore appears to be a detriment rather than an advantage when used with grout filler, as the grout is more apt to hold to the square-edged brick than where the edges are smooth and rounded. Numerous instances were noted of grout-filled repressed brick streets where the grout had been ground out of the brick to the depth of the rounded edge. On the other hand, in wire-cut lug grouted brick pavements the grout in the brick appeared to wear down evenly, so that the surface remained smooth and continuous.

Vertical fiber brick with cement grout filler have hardly been in use long enough to draw any definite conclusions regarding the advantages which have been claimed for them. Such observations as the authors were able to make would indicate that a number of objections to their use with cement grout might exist. Most important of these is the fact that the lugs, being rectangular, touch the adjacent brick over a considerable area instead of at points or lines as in the other types of lug brick. Cement grout can penetrate only the spaces between the lugs, leaving, in the case of the vertical fiber brick, a relatively large area of the sides of the brick over which no adhesion to the adjacent brick is possible. It would seem hardly possible under such conditions to obtain as truly a monolithic bond as exists where practically the entire space between the courses is filled with grout. As before stated, in monolithic and semimonolithic construction, the side bond between the brick should be as strong as possible, in order to protect the bond between the brick and the base. Vertical fiber lug brick were intended primarily for use with bituminous fillers and are now successfully used in this way to a considerable extent in Kansas City, Mo., and Lincoln and Omaha, Neb.

Lugless Type of Brick Open to Criticism.—Experience with the lugless type of vertical fiber brick has been confined almost entirely to Kansas City, Mo. Such observations as were made would indicate that the use of this type of brick was open to serious criticism in that unless great care is used in laying, unequal spacing will result. This was illustrated forcibly in construction work under way in Kansas City. The condition shown in the illustration, while typical of this particular job, is an extreme one. It should be possible to lay lugless brick in much straighter courses than are here shown. It would ordinarily seem reasonable to suppose, however, that a better job of setting would result if lug brick were used, because greater care in selection is necessary in the case of lugless brick if uniform joints are to be obtained. This is due to the fact that in the lugless brick, warping and kiln marks which vary with individual brick are depended upon to form the grout spaces.

Advocates of the lugless bricks maintain that uniformity of the grout spacing is not essential to good construction. This opinion, it seems to the authors, is not well founded in view of the fact that wherever the sides of the brick come into actual contact, as they often do if not spaced carefully by hand, no penetration of grout or filler will be possible. This results in a greatly weakened side bond and permits water to leak through the joints. The first brick pavements built were of the lugless type, but great care was exercised by those in charge of construction to insure uniformly spaced joints. Lugs were introduced simply to insure this spacing automatically. It would seem extremely unwise to run the chance of failure through imperfect grouting simply in order to avoid the use of lug brick. The work already started in Kansas City and that being started in Omaha will be watched with interest.

Joint Fillers.—Among the older streets of many cities in the Middle West are still to be found brick pavements with sand-filled joints. While the majority of these streets are rough and uneven, due both to the cobbling of the individual brick and to unequal settlement of the foundation, a large number still were in fairly good condition. Practically all were in fairly good condition. Practically all were laid on the natural soil foundation. Possessing no slab strength, these sand-filled streets conformed to the contour of the foundation under all conditions, so it is not surprising that after 18 or 20 years they are somewhat uneven. The principle disadvantage of sand as a filler, assuming a stable and unyielding soil condition, is that it does not protect the edges of the brick from chipping out under the action of the traffic. It is more difficult to keep such a street clean, and water is sure to wash down through the joints into the sand bedding course.

The most widely used filler for brick pavement at the present time is Portland cement grout. It has the advantage, if properly applied, of producing practically a monolithic slab capable of resisting bending stresses. On the other hand, this slab, when subjected to temperature changes, expands and contracts like any other monolithic structure, resulting in cracks due to contraction and bulges or heaving due to expansion. Expansion failures usually occur, as would be expected, at the top of vertical curves, or at any other place where for one reason or other the pavement is crowned transversely. Contraction cracks manifest themselves always by the cracking of the grout, usually in a straight line across the road, and ordinarily occur about as far apart as on a concrete road. On account of the greater resistance to abrasion of brick over concrete the contraction cracks in brick roads do not wear nearly as rapidly as in concrete roads, and are, therefore, not as serious a maintenance consideration.

Provision for expansion sidewise against curbs always is made by inserting some form of bituminous joint either poured or prepared, between the brick and the curb or gutter. Provision for expansion longitudinally usually is made in the case of city streets at intersections, while in the case of country highways transverse expansion joints usually are omitted, except under special conditions.

Transverse Joints.—There is aparently some difference of opinion regarding the necessity of transverse joints on both city streets and country highways. In sections where numerous expansion failures have occurred, those in charge of construction are either advocating the use of bituminous fillers exclusively or else regularly spaced transverse expansion joints. The former attitude is illustrated by experience in such cities as Lincoln and Omaha, Nebr., and the latter by the experience in Vermillion county, Ill. A number of types of joints have been tried, such as courses of wood block, as noted in St. Louis, spaced about 75 or 100 ft. apart, or courses of bituminous filled brick spaced about the same distance. In other sections where little expansion trouble has developed engineers seem to prefer to run the chance of an occasional blowup rather than risk excessive wear at joints.

Observations made by the authors would indicate that for city work transverse expansion joints should be installed at street intersections in at least one direction across the intersection and in both directions if the intersection is crowned; while for highways they may be omitted except in special cases, such as curves at the intersections of very long tangents and at abrupt changes in grade. Joints not over ¼ in. in thickness seem to give the best results.

Although there is considerable opposition to the general use of bituminous fillers for brick pavements, good results in using asphalt have been obtained in certain cities west of the Mississippi. The principal disadvange of bituminous fillers appeared to be the lack of protection afforded the brick at the joints; moreover they do not give any slab strength to the brick surface. The former fact was noted in a number of cases on old bituminous filled streets in which the edges of the brick have worn badly. The relative action of traffic on bituminous filled and grout filled joints was noted on those streets where expansion joints consisting of a number of courses of bituminous filled brick had been installed. The difference in wear was very noticeable.

Another disadvantage of bituminous fillers is the tendency, particularly noted in tars, of running out at the sides of the road in hot weather or chipping in cold weather. They possess still another disadvantage of requiring constant attention at the time of application to insure that the temperature of the bituminous material remains at the proper point; since, if too cold, they will bridge the joints instead of penetrating, and, if too hot, they will become hard and inert. On the other hand, they possess the undoubted advantage of being free from expansion troubles. They likewise make a somewhat quieter pavement.

The ease of making service cuts in city streets through this type of pavement is another advantage.

It should be emphasized that when a bituminous filler is used particular care should be taken in its selection in order to avoid the troubles incident to ill-suited materials. In those asphalt filled streets examined in the cities west of the Mississippi, it was noted that by the use of considerable excess of bituminous material a wearing mat of appreciable thickness was formed over the surface of the brick pavement. This mat apparently remains for some years, depending upon its thickness and the character and volume of traffic, and while still intact undoubtedly protects the brick from the action of traffic to a very large extent. This probably is the reason brick streets in this section have worn so little.

Conclusions.—The authors have drawn the following conclusions as a result of their study of brick pavements:

1. The type and thickness of base for any brick pavement should depend upon (a) the maximum weight of the loads to be carried, and (b) the bearing value, under all weather conditions, of the underlying soil.
2. In all cases where the traffic to be carried is likely to be heavy or where the underlying soil is of such a nature that its bearing value is not sufficient to support the pavement under all conditions, a concrete base of sufficient thickness to properly distribute the loads should be provided.
3. Where the maximum weight of the loads to be carried is not excessive and the subsoil is of a porous, well-drained nature, the thickness of the concrete base may be decreased or under very favorable conditions, it may even be omitted altogether.
4. Other things being equal a somewhat lighter construction may be permitted in the case of the "monolithic" and "semimonolithic" types than where the ordinary sand cushion type is provided, on account of the increased slab strength which these types appear to possess.
5. A concrete curb or edging is not necessary when "monolithic" or "semimonolithic" construction is used.
6. Paving brick with well-formed contact lugs are to be preferred to brick without lugs.
7. Paving brick with square edges are to be preferred to brick with rounded edges.
8. Given the requisite care in construction, satisfactory results may be obtained with either cement grout or bituminous filler.
9. Vertical fiber lug brick with bituminous filler have given good service in those cities west of the Mississippi where they were inspected, possibly due to the protecting action of the asphalt mat which prevents wear from coming upon brick direct.
10. Expansion joints in grout filled pavements would seem advisable at street intersections and at points of tangency on curves, and longitudinal joints should be used against all rigid curbs or structures.

Motor Trucks in United States—Ten years ago the number of motor trucks in use was but 4,000. Today there are between 400,000 and 500,000, according to James P. Nash, Office Engineer, State Highway Department, Austin, Texas.

Effect of Tractive Resistance in Terms of Gasoline Consumption

The rapid development of highway transportation due to the increasing use of motor trucks is causing more and more attention to be given to further possible economies that may be attained. Among these economies is that of gasoline consumption. Gasoline is a very important item and its consumption is steadily increasing and so excites the interest and holds the attention of everyone having to do with automobiles and motor trucks.

The amount of gasoline consumed is directly related to the amount of mechanical work done in traveling over the roadway—that is, the amount of resistance overcome in a certain space. There are several forms of resistance such as grade resistance, tractive resistance, air resistance, and resistance due to curvature or road alignment. These various forms of resistance influence the gasoline consumption. Some of these factor have been sufficiently investigated to allow of their influence being shown as in the accompanying charts, which were prepared by Robert C. Barnett, Economic Engineer for the Missouri State Highways Transport Committee.

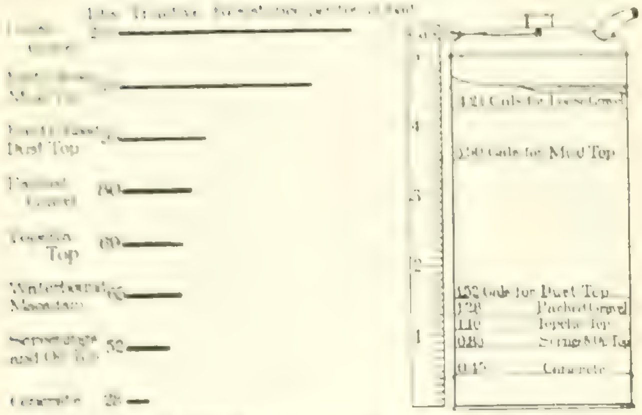


Chart No. 1—Gasoline Consumption for Various Types of Pavements.

Chart No. 1 shows the unit tractive resistance of several types of roads prevailing in California. These values were determined by Prof. J. B. Davidson of the University of California for the Good Roads Bureau of the California State Automobile Association. While other investigators have experimented along this line during the past 50 years. Prof. Davidson's results seemed to have gained a wider recognition. However, these unit values for tractive resistance are incidental to the main purpose of the chart, which is to show the effect of tractive resistance in terms of gasoline consumption. For this purpose an automobile weighing 2 tons when loaded, equipped with an engine and transmission gear capable of delivering 1 HP. per hour to the drivers on a consumption of 1.2 pints of gasoline, was selected. The length of the trip was taken as 20 miles. These represent average conditions. A 5-gal. gasoline can is shown and the different depths of gasoline are marked off proportional to the amount consumed over the different types of roadways.

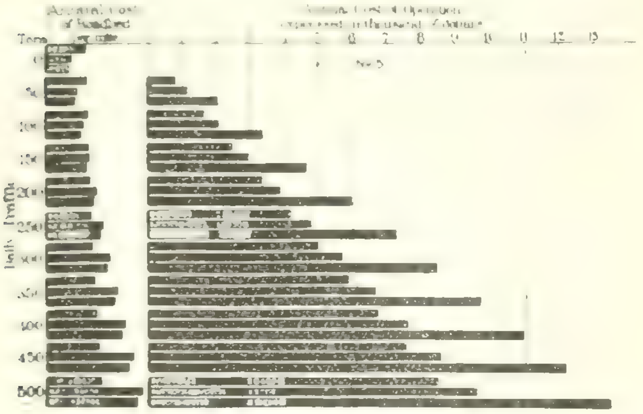


Chart No. 2—Comparison of Annual Costs for Several Types of Pavement.

Chart No. 2 is more complicated and requires a little study to grasp its full significance. It shows the relation between the two groups of factors making up the cost of transportation and indicates how this relation varies as the traffic density changes. Three types of pavement were selected as representing the range of tractive resistance; that is, high, medium and low. The total annual cost of transportation is the sum of the annual cost of roadbed and the annual cost of operation. The annual cost of roadbed was computed for several different traffic densities. This cost embraces the items of interest on construction, annual maintenance, amortization, and administration taken for average conditions. The annual cost of operating over the same roadbed was computed for corresponding traffic densities and includes the items of interest, license and taxes, insurance, administration, garaging, gasoline, oil and waste, driver's salary, maintenance of vehicle and power plant, and amortization.

The important fact to be gleaned from this chart is that the annual cost of operation overtakes and passes the annual cost of roadbed when the traffic density reaches about 50 tons per diem. This has a special significance when considered with the fact that under our existing laws and customs, the roadbed is furnished and maintained by an organization separate and distinct from the parties who operate over it. Hence the failure to appreciate the mutuality of interests and the lack of sufficient co-ordination necessary to attain the maximum economy in highway transportation.

Chart No. 3 depicts the effect of grades in reducing mileage per gallon of gasoline. A type of level roadway is assumed over which the loaded automobile can travel a distance of 16 miles for each gallon of gasoline consumed. The reduced mileage due to different grades is represented by the lengths of the sloping lines. The gallon of gasoline consumed is used to overcome the tractive resistance as well as the vertical lift resulting from that distance and the grade in question.

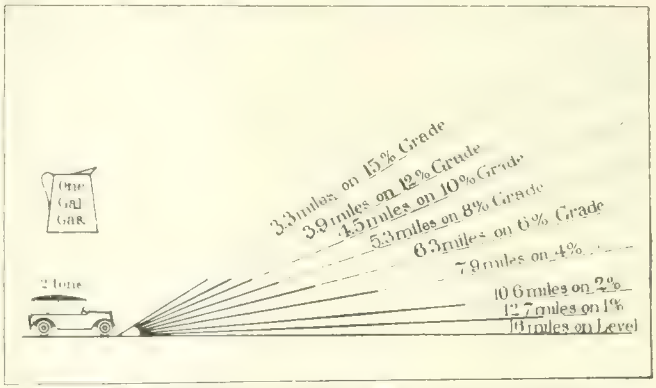


Chart No. 3—Effect of Grades on Running Distances.

Idaho Has License Law for Engineers.—The Idaho Legislature at its recent session passed House Bill 209 for licensing civil engineers. The act defines civil engineering as "the practice of any branch of the profession of engineering other than mining, metallurgical and military" and further states that "Said profession embraces the design and supervision of the construction of all public or private utilities except those in connection with mining operations exclusively and other works which require experience and the same technical knowledge as engineering schools of recognized reputation prescribe for graduation." Powers and duties of the department og law enforcement in relation to practice of civil engineering are to conduct examinations to ascertain the qualifications and fitness of applicants to practice civil engineering; to pass upon the qualifications of applicants for reciprocal registration from other states; to prescribe rules and regulations for holding examinations, to determine what shall constitute a school, college or department of the university for civil engineers and the reputability and standing of such schools (the requirements of the University of Idaho for the degree of civil engineering are adopted as the standard) and to conduct proceedings to revoke certificates. For residents of the state the fee is to $10 and for applicants from the outside $25. Applicants shall be of good character, over 21 years of age; have been in active civil engineering work as assistant or otherwise for at least six years or shall be graduates of a recognized school.

The Relation of Sunlight to Town Planning*

By H. L. SEYMOUR,

Engineering Assistant to the Dominion Housing Commission and Town-Planning Advisor

I wish to recall briefly to your attention some well-known astronomical and other facts about the sun. I then hope to show you that these points should be considered in the determination of the direction and width of streets; height, orientation and density of buildings; and similar matters of more or less importance in planning. Some of these facts undoubtedly have been considered in some cases, and the lay-out or orientation of buildings has been influenced thereby. But I believe I am correct in stating that it is only recently that the application of such facts has been a matter of careful study.

How much weight should be given to this question of sunlight that I am going to discuss must be a matter of judgment in each case; there may be factors or conditions that make it of small importance. But in some instances it is of great importance, and in general, to the town-planner is given the problem of the scientific utilization of sunlight in his layout of streets and buildings.

For the purpose of this paper I propose to consider the light derived during the day under the classifications of (a) daylight or skylight, and (b) sunlight, and it is the latter with which we are mostly here concerned. "Skylight comes from all directions of the heavens; sunlight from only one direction, constantly varying with the revolution of the sphere."

The path of the sun during the four months from April 21 to Aug. 21 resembles more nearly his path at the summer solstice than at the equinoxes, and similarly his path during the four months from Oct. 21 to Feb. 21 more nearly his path at the winter solstice than his path at the equinoxes. Or, the condition of the winter solstice may be considered as fairly typical of the period of the four months from Oct. 21 to Feb. 21. For the northern climes this is the period for which special planning is necessary, as can be judged from the following reasons, with which you are all very familiar but which will bear some elaboration.

At the winter solstice, the days are the shortest, which means that the total possible amount of sunlight that may be received per day is the least in the year. The effect of latitude on the length of the day is readily apparent:

	Lat.	Duration of sunlight
At the summer solstice	42	15.25 hours
At the summer solstice	60	18.90 hours
At the winter solstice	42	9.10 hours
At the winter solstice	60	5.85 hours

At the winter solstice, the sun's rays are most oblique. As you know, the intensity of heat and light received from the sun is greatest as the rays become most nearly vertical. We find then that not only the total amount, but also the intensity of the sunlight received in winter is less than that received in summer. That we should plan to conserve all the sunlight we receive in the northern climes in the winter is the obvious conclusion.

A record of the temperatures in two sun-boxes (small insulated boxes with glass fronts, one faced east and one south) indicates what the December sun can do compared with his ability in July and the other months.

In December, in latitude 42° 40′ N., with an actual outside temperature of 25° F., there was recorded a maximum temperature of 115° F. in the box facing south, while in July, with an outside temperature of 90° F., the maximum temperature in this box was only 112° F., or actually 3° F. lower; in the box facing east, 122° F., or but 7° F. higher.

Mr. Atkinson also instances the case of a small "shack" in latitude 42±° N., with glass front facing south, and says thereof: "A temperature of over 100° F. has been frequently obtained within this building with an outside temperature of zero or lower, entirely from the warmth of the sun's rays."

At the winter solstice, the shadows cast are the longest and cover the greatest area. In this connection some facts are of interest as to some of the New York sky-scrapers. These facts and others in this paper are abstracted from recent papers by Messrs. Swan and Tuttle on "Planning Sunlight Cities" and "Sunlight Engineering in City Planning and Housing."

At noon, Dec. 21, the Woolworth Tower, 791 ft. high, casts a shadow of 1,635 ft. in length.

The Equitable Building at the same time, being 493 ft. high with a ground area of 1.14 acres, casts a shadow 1,018 ft. long, covering an area of 7.79 acres, with the result that the fronts of facades of many tall buildings are completely shaded all day.

The street on the north of the Equitable Building is 34 ft. wide. If this north and south street were built up of Equitable buildings, then "not a single window within 447 ft. of the street level would receive a ray of direct sunlight on Dec. 21."

At noon on Dec. 21 the altitude of the sun is, at the places named, approximately as follows: At the equator, 66.6°; at Winnipeg, 16.6°; at Edmonton, 13.0°.

On east and west streets, if the whole south front of buildings on the north side are to receive sunlight at noon, Dec. 21, then the width of the street must be: At the equator, 0.43 the height of buildings on south side; at Winnipeg, 3.33 that height; at Edmonton, 4.33 that height.

Or the shadow cast at Winnipeg is in length 7.77 times that at the equator; at Edmonton, 10 times that at the equator (at noon, winter solstice).

As the condition at the winter solstice is evidently the most unfavorable for sunlight planning, and because, as shown, such condition obtains to a great extent from about the middle of October to late in February, this condition should be the one to receive the greatest study. If ample sunlight can be provided for this period of four months, our problems, with few exceptions, are solved.

How should a detached building be constructed and oriented so that not only the exterior wall surfaces, but also the surface of the ground around them shall have the direct rays of the sun for as long a time as possible on Dec. 21?

For our investigations let us first take the case of a cube with sides of say 25 ft., this being fairly typical of a small dwelling house, and consider its condition as to sunlight at noon, Dec. 21, if it be located in latitude 42° north. As we build our house further north, the conditions, of course, become more unfavorable.

By orienting our cube, or building, with sides northeast-southwest etc., every side receives sunlight; there is no area of perpetual shadow—and shadow curves indicate that more sunlight is received in the vicinity of the building. It would appear that for a detached building the latter position is preferable.

By adding extensions to our cube or square building, we get another typical building, the "L." The axes of the building should still be at an angle of 45° with the cardinal points, and the interior angle formed by the extension should face the south.

Having established the best orientation for an isolated detached building, the next matter is to determine what effect the grouping of buildings has on the question.

Until the shadows cast by adjoining buildings are such that all sunlight is cut off from some surface of the building under consideration, or until there results a ground area or areas of perpetual shadow, there would appear to be no advantage in changing the orientation of buildings considered favorable for isolated conditions.

Buildings on a north-south street must be much further apart than on northwest-southeast and northeast-southwest streets, if minimum standards of two hours or less of completely lighted walls are enforced for southern exposures.

It would appear, then, that streets in an open rural or residential development, and where no important factor dictates otherwise, should preferably be placed so that buildings thereon and with faces parallel thereto, have their sides at an angle of 45° with the cardinal points.

This means that streets in such a development should run northeast-southwest and northwest-southeast, and not north-south and east-west as is the general custom.

The plan of the townsite of Kipawa, P. Q., shows an actual case in course of development. The development is so open that each house and even every building in the business section can be treated as a separate unit, so far as sunlight and shadow are concerned.

The streets are not square with the cardinal points, but

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*From a paper read before the Ottawa Branch of the Royal Astronomical Society.

[illegible]

[illegible] Horace Bushnell [illegible] "Work and Play," said:

"[illegible] the health of the city, in what direction, or according to what points of the compass, the streets are to be laid. To most persons it will appear to be a kind of law that the city should stand square with the cardinal points of the compass—north, south, east and west, and where this law appears not to have been regarded [illegible] an oversight and even have it as the standing regret of their criticism. Whereas, as the true economy of health and comfort, no single [illegible], squared by the four cardinal points, if it can be avoided. On the contrary, it should have its lines of frontage northeast, southwest, northwest and southeast where such disposition can be made without injury in some other respect; that so the sun may strike every side of exposure every day in the year, to dry it when wet by storms, to keep off the mould and moss that are likely to collect on it, and remove the dank sepulchural smell that so often makes the tenements of cities both uncomfortable and poisonous to health."

Mr. Bushnell has applied the considerations that affect single buildings and open development to the conditions of close or urban development. With this conclusion, Atkinson also agrees.

The space between rows is, in many cities, the width of the street, no set-back being insisted on. Mr. Atkinson in this connection states in his "Orientation of Buildings":

"In the north-south street the distribution is symmetrical, the buildings on either side receiving an equal amount. In the east-west street the north face of the street receives no sunlight during six months of the year, and the buildings on the south side are in perpetual shadow during the same period. In planning towns, the east and west street should be avoided as far as possible and where unavoidable, the buildings should be of moderate height and built in detached blocks. In the checkerboard plan, the best distribution of sunlight is obtained when streets run northeast-southwest and northwest-southeast."

Messrs. Swan and Tuttle have approached the whole matter from a different angle—not starting with a study of detached buildings—and have considered a development almost entirely on New York lines, where closely placed or contiguous high buildings face only on the main and not, to any extent at least, on the cross streets. The main street will receive most sunlight when it is oriented north and south. This conclusion is supported by many useful tables prepared by Swan and Tuttle. And it is shown that while no sunlight may be received all day on an east-west street as far south as latitude 30°, yet in latitude 50° north, under the same conditions, a north-south street receives over an hour of sunlight.

"Blocks improved with houses in rows or with apartment houses, then, should have their length parallel to north-and-south streets and their breadth parallel to east-and-west streets." But such a development is generally neither economical or desirable, even though very common. Mr. Adams has submitted, in his "Rural Planning and Development," alternative schemes of development, resulting in almost square instead of long narrow blocks. Assume these buildings for the moment to be attached in rows, to be in height one-half the "street" width between these and similar buildings on opposite sides of the street, and to be located in Winnipeg, latitude 50° north. Then we find from Messrs. Swan and Tuttle's tables that on Dec. 21, houses near the centers of the sides of the block (or sufficiently far from the street intersections to be uninfluenced by sunlight conditions there) will have their fronts exposed to direct sunlight for:

[illegible] square with cardinal points		Angle of 45° with cardinal points	
North side	0 h.	Northeast side	0 h. 22 m.
East side	1 h. 52 m.	Southeast side	2 h. 39 m.
South side	[illegible] h.	Southwest side	2 h. 39 m.
West side	[illegible] h. 52 m.	Northwest side	0 h. 22 m.
	[illegible] h. 44 m.		6 h. 02 m.

Evidently the angle of 45° with cardinal points is to be preferred, though as the height of building and latitude increase, the advantages disappear.

If east and west streets are to be built up, there seems to be no doubt among the authorities that buildings should be detached.

"The amount of sunlight obtained on east and west streets in private house districts may be effectively increased by staggering the buildings in such a manner that no house is directly back of one in front in the same block."

Raymond Unwin, the author of, I believe, the best architectural work on town planning, states that many people desire a south front to their house, in which case east-and-west roads are generally necessary. Though, "in France, where a road runs north and south and it is desired to give the houses a southern frontage, one often sees little rows of houses placed with their ends to the roads, access being obtained by a simple pathway."

Freight Charges and Multiple Bids for Illinois Road Work

At a conference between the Illinois State Division of Highways and contractors held in Chicago on Monday, April 14, a number of questions were raised of considerable interest to those who are proposing to bid on road work advertised by the State Department of Public Works and Buildings, Division of Highways. The following statement given out by the department is of interest to prospective bidders on Illinois road work:

Freight.—An announcement has been made by the United States Railroad Administration that on stone, slag, shells, chatts, chertz, sand and gravel, a reduction of 10 ct. per ton from the regularly published tariff rates at the time the shipment moves, will apply on such materials when purchased for road use by the federal, state, county, parish, township, or municipal governments. These rates are subject to a minimum charge of 40 ct. per net ton, except where the regularly published commercial rate is less than 40 ct. per net ton, in which case the published rate applies.

All bidders are expected to base their proposals on the reduced freight rates above outlined. All contracts entered into will contain a clause to the effect that in case freight rates are increased after the date of the receipt of bids and before the date set for completing the work, the contractor will be paid extra an amount equal to the increase in freight charges; and in case of a reduction in freight rates a corresponding deduction will be made from the payments otherwise due the contractor.

Multiple Bids.—When a contractor makes a combined bid on more than one section of work, only such combinations will be considered as are outlined in the notices sent out from this department. Where a contract is awarded on a combined bid contracts will be written for every individual section included in the combinations, and the gross amount for each individual section will bear the same ratio to the combined bid as the amount named by the bidder for each individual section bears to the sum of his bids on the individual sections. The unit prices will also be pro-rated in the same manner.

When a combination bid is submitted, the certified checks for the several sections making up the combination may also be considered as covering the combination bid.

"Safe Sight Distance" for Automobiles.—Tests made by the New York State Highway Department with 5-passenger automobiles show that the distance required to bring the machine to a stop is as follows:

Speed.	Distance. Ft.
20 miles per hour	40
[illegible] miles per hour	140

Numerous tests for "safe sight" distance have been made and it has been generally decided that 300 ft. is a "safe sight" distance for a speed of 25 miles; and 200 ft. for a speed of 20 miles. The minimum sight distance should be 100 ft.

The Cost of a Mile of Road*

By GEORGE A. DUREN,
State Highway Engineer of Texas

The three diagrams herewith present the elemental facts pertaining to the cost of a mile of road. Figure 1 shows transportation costs for motor vehicles for varying grades and surfaces. Figure 2 is based on facts as set forth in Fig. 1, to show the annual cost of a mile of road, including interest on the cost of construction, cost of maintenance and cost of traffic for varying costs per ton mile. Figure 3 shows the cost per ton mile, including the transportation cost per ton mile paid by the user of the highway and the cost per ton mile of the highway itself, which is paid for by the taxpayer in highway construction and maintenance.

All the highway authorities have been dealing with highway construction and maintenance almost solely in an effort to deal with this subject at the least possible cost on the part of the taxpayer with little or no consideration for the cost of transportation.

The authorities agree that a 9-ft. gravel road is a satisfactory and economical highway for traffic not to exceed 200 vehicles per day and that a 16-ft. gravel road is a satisfactory and economical highway for use of vehicles not to exceed 500 per day. Authorities differ concerning the automobile highway for traffic of from 500 to 1,000 vehicles per day, but the general opinion is that for this traffic some form of bituminous surface is most satisfactory. It is suggested that for traffic exceeding 500 vehicles per day and not exceeding 750 vehicles per day, a macadam road with bituminous surface treatment should be used; and for traffic exceeding 750 vehicles per day and not exceeding 1,000 vehicles per day, a substantially built asphalt macadam construction should be used. Traffic exceeding 1,000 vehicles per day should be served with a concrete paving, not less than 16 ft. wide. For traffic amounting to as much as 2,000 vehicles per day, a concrete pavement 20 ft. wide should be used and that for traffic exceeding 1,500 vehicles per day a brick pavement is desirable. Traffic exceeding 2,000 vehicles per day should be served with a pavement not less than 20 ft. wide and constructed with concrete foundation not less than 5 in. thick with brick, wood block, rockasphalt, sheet asphalt, granite block or some form of asphaltic concrete not less than 2 in. thick should be used. These conclusions are probably in keeping with economy when viewed only by the cost of building and maintaining the highway under the varying intensities of traffic for units formerly used. All of these types of construction are such as will enable traffic such as formerly was found on the highways to continue 365 days a year. Traffic amounting to less than 50 vehicles per day has been provided for by earth roads occasionally graded and dragged. Traffic amounting to 1, 5 or 10 vehicles per day has been accustomed to getting along the best it could over the natural surface of the ground.

The approximate costs of transportation are as follows: Upon an unimproved road 30 ct. per ton mile; on an improved earth or sand clay road, 25 ct. per ton mile; on a hard gravel road, 20 ct. per ton mile; on a bituminous surfaced gravel road, 15 ct. per ton mile; on a concrete or brick road, 10 ct. per ton mile.

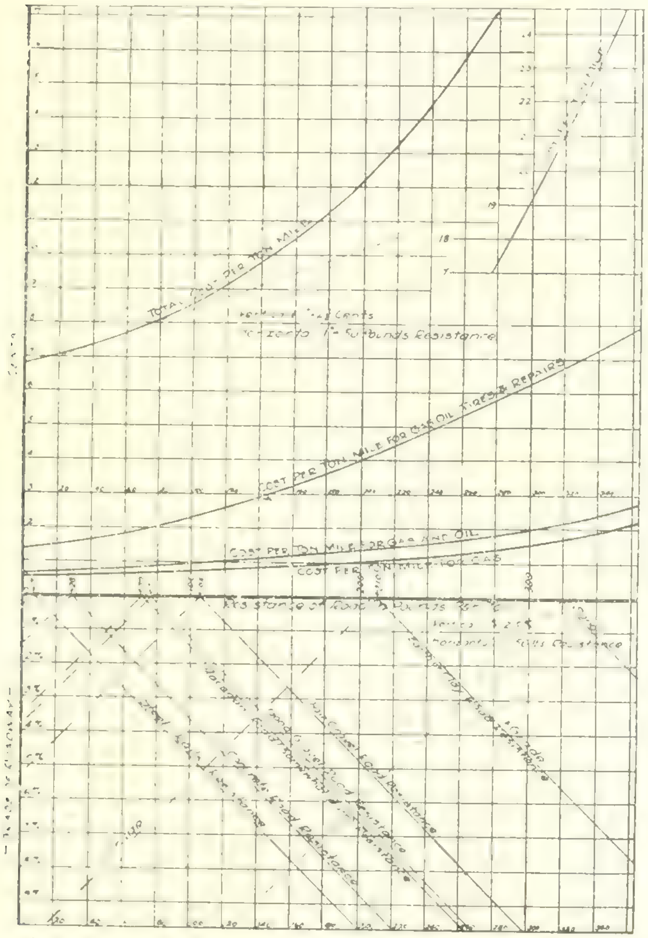

Fig. 1—Transportation Costs by Motor Vehicles for Varying Grades and Surfaces.

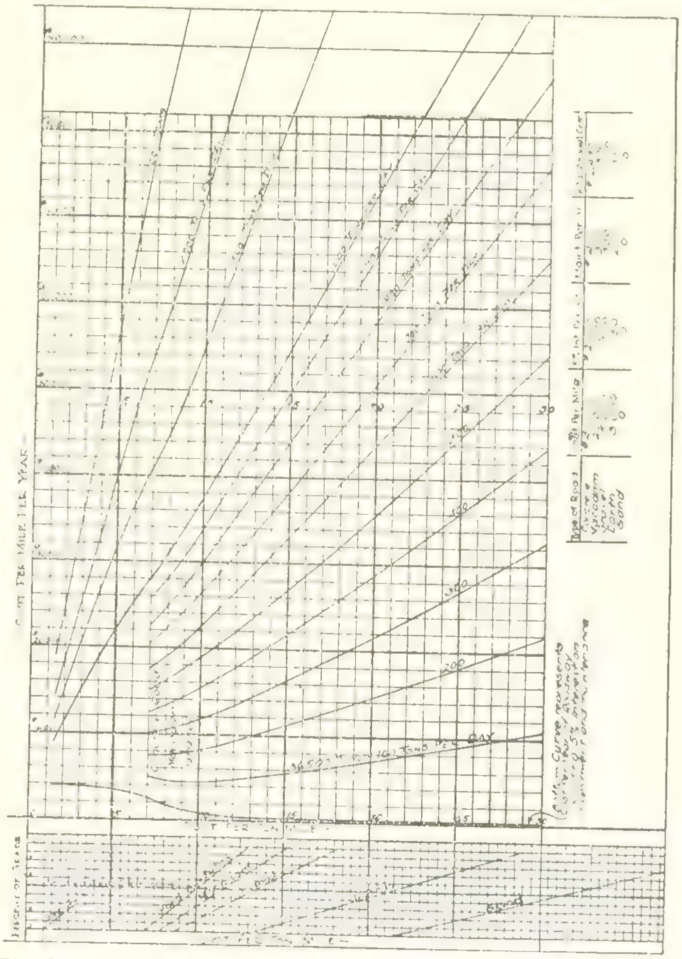

Fig. 2—Annual Cost of a Mile of Road, Including Interest on Construction Cost, Cost of Maintenance and Cost of Traffic for Varying Costs Per Ton Mile.

Figure 3 is based on more conservative assumptions as follows:

Cost per ton mile on 9 ft. gravel road, [illegible] ct.
Cost per ton mile on 16 ft. gravel road, 21 ct.
Cost per ton mile on 16 ft. bituminous road, 20 ct.
Cost per ton mile on 16 ft. asphalt macadam road, [illegible]
Cost per ton mile on 9 ft. concrete road, 18 ct.
Cost per ton mile on 16 ft. concrete road, [illegible] ct.
Cost per ton mile on 16 ft. brick road, 16 ct.

The tonnage of traffic is assumed at one-half the number of vehicles and the annual cost of the road assumed also is conservative and most favorable to the cheaper type of construction.

The cost of a road is essentially an annual cost. Man has not yet constructed any permanent structure and no highway has yet been constructed which if it is used does not require annual expenditure for maintenance. This rule applies to the Appian Way and every other road. We have not lost the art of road building, but we have lost the willingness to spend a sufficient amount of money on the road.

A permanent road is a road that is permanently maintained.

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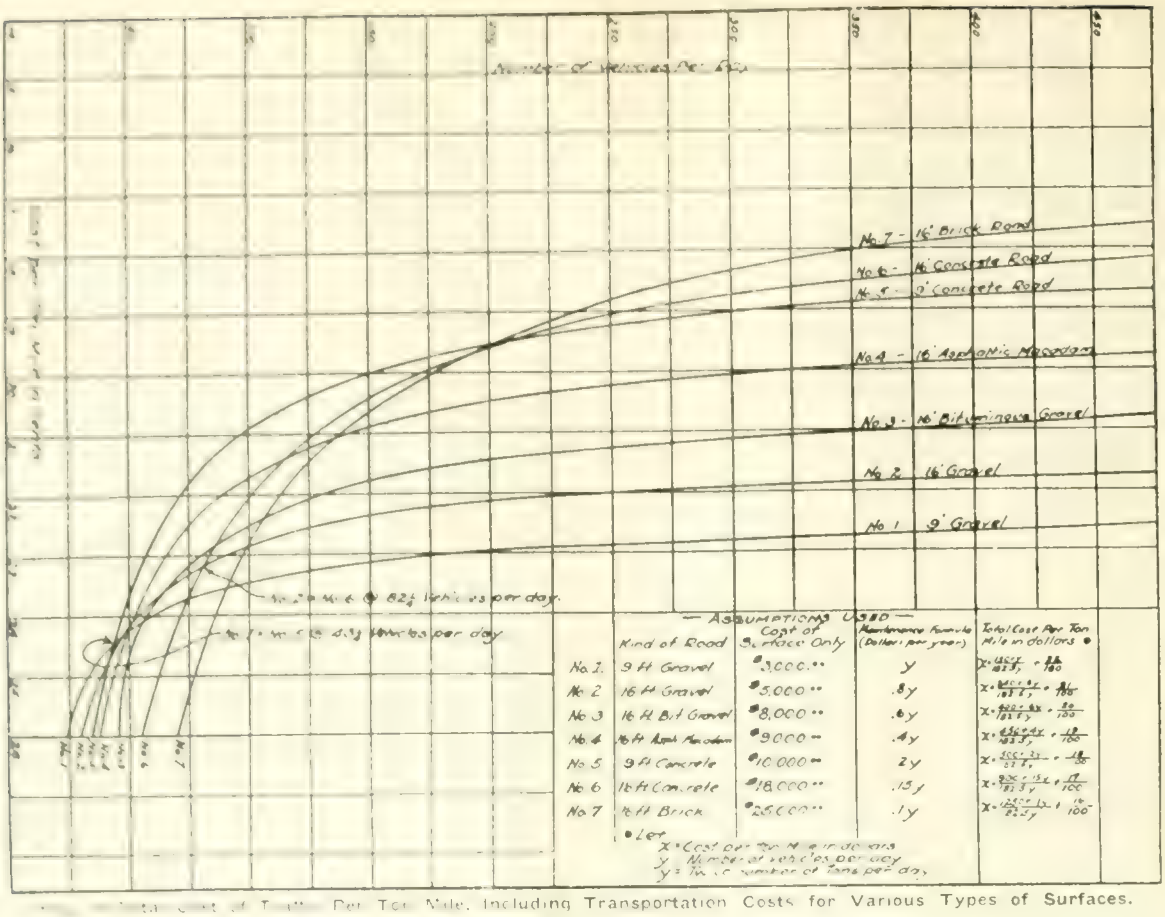
*From a paper presented April 15 at an Engineering and Road Builders' Congress at Mineral Wells.



[illegible] Total Cost of Traffic Per Ton Mile, Including Transportation Costs for Various Types of Surfaces.

[illegible] road per year. Too much attention is given to the original cost of construction and too little interest and attention is given to the cost of permanent service. A rational study of the cost of a mile of road must be arrived at by adding the interest on the original investment to the cost of annual maintenance necessary to retain the original structure. This seems all that must be considered as a part of the cost of the road; however, the most important matter to be considered is the cost to the traffic using the highway as affected by the condition of the highway.

The use of the road occasions a cost to traffic amounting to a certain rate per ton mile. The improvement of the road is an economic waste unless a saving is effected by its expenditure as an investment in reducing the cost of the traffic using the road. The cost per mile of road per year should never exceed the reduction in the cost of transportation using said mile of road, made possible by the improvement.

E. H. Harriman is remembered as being a railway wizard as well as a financial genius. He took over unprofitable railways and bankrupt railways and spent millions of dollars on these losing ventures to improve the roadway, reducing the grades and laying heavier rail and building better track. He did not reduce the cost per mile per year of maintaining the track thereby, but he did reduce the cost per ton mile of all traffic using the road, thus transporting the tonnage at an enormous saving which went into dividends. Yet he was able to accomplish only the small saving of approximately ½ of 1 per cent per ton mile.

Florida Proposes Bond Issue for Road Work.—A special committee has reported to the legislature of Florida recommending that the state be bonded to raise funds to carry out a plan for a comprehensive system of highways. The committee submitted three proposed measures with the report: One bill abolishes the convict lease system, another imposes a two-mill tax with which to meet Federal aid and sustain convicts on the public roads, and a joint resolution seeks to submit to the people an amendment to the constitution allowing for the bonding the state for good roads, provided such bond issues as may be authorized by future legislatures under this amendment shall not exceed 5 per cent of toal tax assessment of the state at the time of such issue.

Illinois Opens Bids on 111 Miles of Federal Aid Road

The first road letting of the present year by the Illinois Division of Highways was held April 23 and 24 when bids were opened for constructing sections of Federal Aid roads. The work covered 222,969 lin. ft. of the Dixie highway in Iroquois and Kankakee Counties and 366,862 lin. ft. of the Lincoln highway in Du Page, Kane, DeKalb, Ogle, Lee and Whiteside counties. On the Dixie highway work seven bids were received, Bates & Rogers, Chicago, being the only contractors to bid on the entire job. The low bidders and number of bids on each section were as follows:

Section.	No. of bidders.	Low bidder.	Amount.
1	1	Bates & Rogers	$180,729
2		Cameron & Joyce	98,093
G-15D	2	Bates & Rogers	32,946
3	3	Cameron & Joyce	81,192
H-15D	[illegible]	Cameron & Joyce	21,633
5	1	Bates & Rogers	213,990
K-15d	3	Federal Paving Co.	46,190
6	4	Chicago Heights Coal Co.	[illegible]
7	1	The Embankment Co.	144,109

Bates & Rogers also submitted a combination bid of $310,000 for the first three sections, a bid of $320,000 for the next three and a bid of $370,000 for the last three. The Federal Paving Co. submitted a combination bid of $346,000 for the last three sections, and the Chicago Heights Coal Co. put in a combination bid of $350,000 on these sections.

The low bids and number of bidders on the various sections of the Lincoln Highway were as follows:

Section.	No. of bidders.	Low bidder.	Amount.
1	4	Calumet Concrete Construction Co.	$ 79,593
G	2	Calumet Concrete Construction Co.	45,446
2		Calumet Concrete Construction Co.	34,180
3		Illinois Hydraulic Stone & Const. Co.	38,007
L-15d	2	Illinois Hydraulic Stone & Const. Co.	69,935
4	3	Bates & Rogers	110,955
5		Bates & Rogers	36,106
6	3	Bates & Rogers	92,120
7	4	Illinois Hydraulic Stone & Const. Co.	93,102
G	1	Hart & Page	17,660
8	1	Hart & Page	29,346
1	1	Hart & Page	6,852
9		[illegible] Rutledge	103,887
[illegible]-15d	1	Keokuk Quarry Construction Co.	56,603
12	1	Keokuk Quarry Construction Co.	68,110
[illegible]	2	C. E. [illegible]	[illegible]
17		Bates & Rogers	103,347
H W [illegible]		[illegible]	12,662
15		Bates & Rogers	155,171
E-15	1	Drinnin & Clark	30,492

Highway Bridges and Heavy Motor Truck Traffic

The committee on "Methods of Strengthening and Reconstructing Highway Bridges for Heavy Motor Truck Traffic" in a progress report presented at the recent convention of the American Road Builders' Association, estimated that there were about 400,000 public highway bridges in the United States, 80 per cent of which probably are unable to carry a modern heavy truck with a reasonable margin of safety. An abstract of the report follows:

A committee of the National Highway Traffic Association is considering the question of the weights, etc., to be allowed on public roads and until their report is adopted it may not be advisable to lay down definite standards for determining the necessary strength of old bridges; but it may be well to call attention to the following facts: A well designed, well constructed, well maintained reinforced concrete bridge will, so far as we can see, last for centuries. Trucks rated now as heavy may appear puny in 1975. Steel bridges, well designed, built and maintained will last at least 50 years and probably much longer. The engineer is, therefore, using good economy in looking well into the future in designing new bridges, because the extra cost of building a bridge of ample strength now is only a fraction of the cost of replacing it with a new one at some future time when much heavier trucks may come into use. If an old bridge is to be strengthened, it is only a temporary make-shift at best and the engineer is not justified in looking many years ahead in deciding on the assumed loading.

In the course of an investigation by a committee of the New York Legislature, it developed that there were in that state, about 33,800 public highway bridges more than 5 ft. in span, which would indicate that there are about 400,000 such bridges in the United States. It is safe to say that the failure of any one of a very large proportion of them would be likely to cause loss of life. It is also probable that more than 80 per cent are unable to carry a modern heavy truck, with a reasonable margin of safety.

Suggestions for Bridge Inspection.—Every one of these bridges should be inspected at least once a year by a competent man. A majority consist of a single span of wooden stringers with plank floors. In the case of such bridges the main points to be observed are the safety of the abutments, the sufficiency of the width, the safety of the railing, the adequacy of the waterway and the strength and soundness of the stringers and planking. All these points require sound judgment and a reasonable amount of engineering knowledge. With the larger bridges the responsibility is greater and the danger of loss of life in case of failure is also greater. Many bridges require inspection oftener than once a year. All steel bridges should be painted every 3 or 4 years by competent men who should be carefully instructed to report all defects observed. Many parts of steel bridges are not accessible for proper inspection without the use of scaffolding such as painters use. It is not always practicable to employ such scaffolding during the annual inspection.

In preparation for the advent of heavy trucks all public bridges should be examined by competent men who will make a record of the character of the traffic likely to come upon the bridge, the dimensions and conditions of all vital members and the sufficiency of the details, and written report of such inspection should be forwarded to the proper state department for record. From these reports it must be decided which bridges require complete reconstruction, which require new superstructures and which can be repaired and strengthened. The necessary plans can then be prepared and should be checked on the ground. These inspectors should be paid by the public, preferably on a salary or per diem basis. It should as a rule be done by men who are not financially interested in the construction of bridges by contract.

Strengthening Bridges.—The strengthening of bridges often requires far more engineering skill and ability than the design and construction of new ones. As to how this work should be carried out, much depends on circumstances. Estimates of cost are sometimes misleading. Unit costs of repair or alteration work in place are often more than twice the unit costs of similar material in new work. When an engineer starts to repair an old bridge he is almost certain to find a considerable amount of work that must be done that he had not anticipated. For these reasons it is usually best to have the material furnished or fabricated by contract and the field work done by days' work if a reasonably efficient gang can be organized. Expensive equipment such as pile-drivers, air compressors, etc., may be rented on a per diem basis.

If it is a well defined job such as replacing a floor system or an abutment it can be done satisfactorily by contract; otherwise a bidder is confronted with the same difficulty as the engineer in estimating his cost and will either bid high to cover risk and uncertainty, or will bid reasonable prices, expecting to make up with his bill of extras, which will be no small item. Often, however, a cost-plus contract is preferred, but it must be so worded that it is either to the contractor's interest to furnish proper tools and equipment or he can be forced to do so. It is not always practicable in such cases to insure that the work can be done within the appropriation.

Another difficulty often encountered in a repair job handled by a lump sum contract may be illustrated as follows: The engineer estimates $10,000 as an outside figure for the job; he secures an appropriation of $15,000 to cover extras; the bidders have no way to estimate accurately their cost and are apt to be guided by the amount of the appropriation and bid about $14,000 leaving far too small a margin for extras. If an efficient gang cannot be organized the cost plus a fixed sum system is generally the best, except that on public work, public opinion must always be considered and many people have an idea that the cost plus a fixed sum contract is only good for war work and similar work in which the maximum speed is absolutely necessary regardless of cost.

The committee does not consider that in deciding whether any given member of a bridge needs strengthening, it is necessary to hold strictly to the letter of the standard specifications in the matter of unit stresses. In fact a deficiency of 20 per cent in material is not serious provided the details are good and the material is in good condition, it being felt that the usual unit stresses adopted make that much allowance for deterioration, besides secondary stresses, etc. Less allowance, however, should be made in the case of floorbeam hangers, stringers and floorbeams which are subject to widely and rapidly varying stresses. In considering the strength of a bridge truss it is not necessary to assume that the bridge is packed full of trucks of maximum weight, but if the bridge is 16 ft. wide or over, it is always possible that two heavy trucks may pass on the bridge.

The committee feels that in cases where the strengthening of a bridge will make it, in effect, a permanent structure, the bridge should be designed to carry a truck weighing at least 20 tons, the idea being that the committee having this matter under consideration is concerned primarily with the roadway paving, as to which the loading specifications can be economically revised within the next 10 or 15 years, on account of the wearing out of the pavements, whereas a bridge is a much more permanent structure.

The committee fully recognizes that the immediate strengthening of all the bridges in the country that need it, together with the reconstruction of those which cannot be economically strengthened, is a physical as well as financial impossibility. It would, therefore, recommend that immediate steps be taken to have a thorough examination made of all important structures by competent engineers and their safe loads determined and indicated by proper signs to the end that the public be protected so far as is humanly possible. Any person who disregards these notices and suffers disaster has only himself to blame. The work of preparing plans for strengthening should then proceed without delay so that construction will be delayed as little as possible

Rebuilding Small Bridges.—The small bridges will generally have to be rebuilt; the steel truss bridges will generally be found fairly strong in the trusses, but altogether too weak in the floor system. Many steel bridges have suffered seriously from neglect of painting and other maintenance. Very frequently the steel about a foot above the bridge floor is very badly corroded. In such cases tension members would have to be reinforced, which can generally be done if they are of structural shapes, but if the bridge is pin-connected, the bridge can be supported on false-work and new tension members inserted. Corroded compression members can very often be effectually and permanently strengthened by concreting in the corroded parts. The concreting should extend beyond the corroded parts far enough to secure sufficient adhesion. Defective details will generally have to be corrected, even at considerable expense. The attempt is sometimes made to strengthen a truss by putting another alongside it. If this is done great care must be taken that each truss carries its share of the load. The new trusses should be supported on [illegible] which [illegible] connections should be made to both the old and new trusses. The upper bracing should be connected to [illegible] so as to give them lateral stiffness. If the stringers are somewhat weak their number can be increased at a small additional expense. If the stringers are very weak they should be replaced with new ones of sufficient strength. Weak floorbeams can sometimes be strengthened by riveting on new cover plates. The floorbeams should be carefully considered for bending as well as for design and if necessary replaced with stronger ones.

Strengthening Steel, Timber and Stone Bridges.—Few of the old steel bridges are strong enough to carry paved floors, although these can be replaced with a new creosoted wood set on edge [illegible]. This will give a much more durable floor and one much less likely to break through under heavy loads. The weight of this is little greater than that of a plank floor. Plate girders can often be strengthened by riveting on additional cover plates. Riveted lattice trusses can often be reinforced to carry paved floors without throwing away and starting anew. Pin-connected trusses can rarely be strengthened and occasions will frequently arise in which it is necessary to support the floor by means of timber bents, consisting of piles, if the bottom is soft, or by means of mud-sills and posts, if the bottom is hard. If these are used they should be placed under all the floorbeams, the outer posts being about 2 ft. inside the center lines of the trusses. This method, of course, is not suitable if the stream is likely to carry much drift-wood or floating ice.

Timber truss bridges can often be strengthened, for, if as is frequently the case, the floor only is weak, it is generally possible to put in heavier timber in the floor or to strengthen it with steel to carry heavy trucks. Stone arches are almost always amply strong to carry the load if they are in good repair, but it is sometimes necessary to remove the earth covering and grout the joints between the stones to give them a full bearing.

Stone arches, moreover ,will usually show signs of distress long before total failure. It is rarely possible to strengthen a plain or reinforced concrete arch. If a truss is weak it seldom increases its strength to place bents under the floorbeams unless all the floorbeams are supported in the same way, taking the load almost entirely off the trusses. Plain concrete arches are more likely to fail suddenly without warning than almost any other kind of bridge. It is, of course, understood that all plans for strengthening bridges should be made and carried out under the direction of a competent engineer. Many bridges are not safe to carry auto truck traffic on account of being so narrow as to be dangerous to vehicle traffic at high speed, but it is much better for a truck to reduce speed at a bridge than to break through it. Pending the strengthening of any existing bridge, it should be examined by a competent engineer and the heaviest load which it can safely carry should be indicated by proper signboards.

The question of detouring traffic while a bridge is under repair is often quite difficult. It is frequently possible to support the old bridge with bents and maintain traffic over the bridge during repairs, although this method adds considerably to the cost of repairs. Sometimes a timber trestle can be built alongside or in the vicinity.

If a bridge is to be replaced, it is sometimes possible to move it bodily sidewise on temporary supports and construct new temporary approaches.

The list of bridges which have failed under heavy trucks, with or without loss of life, is a long one. In the vast majority of cases, it is only the planking or the stringers which have broken through.

It is the duty of officials in charge of public highways to maintain them in such condition that they are safe and convenient for all reasonable and lawful traffic which may come upon them; and the limit of loading on bridges of a state should be fixed by statute in order to determine what are reasonable and lawful loads, it being understood always that any private parties desiring to transport heavier loads on them, than is provided for by statute, can do so by paying the extra cost of making the bridges of the desired strength.

Unit Bidding Prices and Labor and Material Prices for State Road Work

An attempt has been made to obtain information regarding the bidding prices received at the earlier lettings for state road work. The notes following are extracts from replies to a letter sent early in April to various state highway departments:

Alabama.- Up to date (April 12) we have not let enough contracts to justify a comparison of the cost with last year's work. On April 7 we awarded a contract at the following prices:

Common earth excavation, 30 ct.
[illegible]
[illegible] per pound.
[illegible] haul, [illegible]

The few contracts that we have awarded would indicate that there is a slight tendency on the part of the contractors to decrease the bid prices.

Colorado.—The present labor prices are practically the same as at this time (April 28) last year, the ordinary labor running from 40 to 50 ct. an hour and up to $6 and $7 a day for more expert labor. The last contract prices which we received in the southeast section of the state ran from 32 ct. to 44 ct. a yard for common excavation—44 ct. for ordinary loose rock classification and $1.25 to $2 a yard for solid rock; reinforcement prices ran from $7 to $15 per 100 lb. for square twisted bars of various sizes. The commission rejected all the bids, and will proceed to construct the work with its own forces.

Connecticut.—The following is a comparison of contract prices on state road work three years ago and the prices at present:

Earth was 60 ct. per cu. yd., today 90 ct.
Rock was $[illegible] per cu. yd., to-day $3.
1:2:4 concrete for road work was $9 per cu. yd., today $12.
7-in. macadam was 75 ct. per cu. yd., today $1.20.
Labor was 20 to 25 ct. per hour, today 30-40 ct.
Trap rock at the quarries was 60 ct. per ton, today $1.10.

In general you will note these prices have increased approximately 50 per cent. Conditions as far as supply labor is concerned are very favorable.

Maine.—We have not at this writing (April 12) let any contracts this year so have no direct information on present contract prices.

In conversation with several contractors who are completing contracts undertaken last year and the year before, and from a little employment of labor on force account work for ourselves, it appears that common labor will probably be paid 35 ct. per hour this season as against 40 ct. per hour last year. We have hired in some places at 30 ct. per hour this spring but I imagine the price will go up a little later.

Material prices are slacking off a little. No marked decrease has been made in the price of lumber but it appears to be a little easier than it was a year ago. Of course you are familiar with the lower prices on cement and steel which have recently been named, also the reduction in freight rates on road-building materials, all of which will have a tendency to encourage more highway construction throughout the country.

Massachusetts.—The following schedule shows the average contract prices for various items in 1916, 1918 and 1919:

Item	1916	1918	1919
Earth excavation	$0.77	$1.50	$1.36
Ledge	2.50	4.50	3.62
Borrow	.82	1.63	1.27
Local broken stone	1.86	2.90	3.05
Trap rock (by rail)	2.57	3.60	4.13
Bituminous application	.06	.10	.08
Concrete [illegible]	15.0[illegible]	23.33	21.3[illegible]
10-in. vitrified pipe	.77	1.00	1.10
12-in. vitrified pipe	.90	1.50	1.15
18-in. vitrified pipe	1.60	2.00	2.00
12-in. corrugated iron pipe	1.20	2.25	2.25
14-in. corrugated iron pipe	1.45	2.40	2.35
16-in. corrugated iron pipe	1.50	2.75	3.25
Catch basins	37.00	50.00	62.50

Cement costs at the present time about 50 per cent more than in 1916; asphalt and oil only about 20 per cent more than in 1916. Labor in 1916 was about 30 ct. per hour, whereas at the present time it is about 50 ct. per hour.

New Jersey.—Replying to your letter, the only bids we have received thus far (April 14) were for the construction of 5 miles of concrete pavement 18 ft. in width, 6 in. thick at the sides, 8½ in. thick at the center, 1:2:3 mix on State Highway Route No. 6 in Gloucester county. The John M.

Kelly Contracting Co. of Camden was the low bidder of nine bids received, the contract price being approximately $180,000, his bid on the concrete pavement being $2.15 per sq. yd.

Prices are little if any lower than last year's prices, except that cement is lower by 15 ct. per barrel, and a recent decision of the Railroad Administration lowers the freight rates on road building materials effective May 1st by 10 ct. per ton, both of which, together, will have the effect of reducing future bids considerably. One and a half inch crushed rock for concrete pavement work is selling at $1.20 per ton, f. o. b. cars quarry, 1½ gravel, suitable for concrete work, is from 80 ct. to $1.00 per ton at pit. Sand is from 75 ct. to $1 per ton at pit. We expect to receive a number of bids during the second week in May which will probably set the general prices for the summer's work.

Oregon.—In general, our experience has been that there has been no reduction in prices over work awarded last year. However, we find that we cannot make definite comparisons inasmuch as there were very few bidders last year and frequently jobs were advertised upon which no proposals whatever were received.

In general, it is assumed in this vicinity that labor will be about the same as last year; that is, the average wage is $4 per day for 8 hours, although some predict $5 for the same period. However, up to this time, we have found that labor is about 50 per cent more efficient than last year, due to the fact that there is at this time a little surplus which is rapidly diminishing during the last few weeks.

There has been no appreciable reduction in the prices of materials.

Wisconsin.—We have made no general comparison of this year's prices with last but in a general way know that they are a little higher, but just what percentage I am unable to state.

Our sand and gravel fit for concrete road purposes is costing us about 45 ct. to 65 ct. per ton f. o. b. plants. This is about 10 per cent in excess of what we paid last year. The companies were asking a somewhat higher price than this earlier in the season but have come down to some extent.

Crushed stone is costing us from 90 ct. to $1 per ton at the plants.

On over $600,000 of work recently awarded the grading price varied from 35 ct. on heavy jobs and fairly good material, to as high as 90 ct. where there was a small amount of fairly difficult grading.

The concrete paving on this same work varied from $1.90 to $2.12, the latter of which was ½ in. thicker than the other work. The culverts on this same work varied from $14 to $22.

Virginia.—Little work was let to contract in this state last year. However, under similar conditions prices this year are from 10 to 15 per cent less than those last year. The present prevailing prices of material in this state are from 100 to 150 per cent above pre-war prices. At this time labor will average about $2.50, which is just 100 per cent above pre-war prices.

Hard Surfaced Roads in Florida.—According to the recently issued biennial report of the State Road Department, Florida has 4,767 miles of hard surface roads, classified as follows:

Material.	Miles.
Brick	463
Concrete	8
Asphaltic concrete or sheet asphalt	411
Penetration or surface treated macadam	376
Plain macadam	595
Shell	[illegible]
Marl or sand-clay	2,282
Total	4,767

Oklahoma to Vote on $50,000,000 Road Bond Issue.—Citizens of Oklahoma will vote at a special election on May 6 on authorizing a bond issue of $50,000,000 for the construction of a state wide system of paved highways.

Montana May Issue $15,000,000 of Bonds for Roads.—The Montana Legislature has passed a bill providing for a $15,000,000 bond issue for the construction of state highways.

Illinois May Operate Gravel Plant.—A bill is before a commitee of the Illinois Legislature appropriating $125,000 for the erection of a gravel plant to work deposits at Tamms, in Alexandria County.

Special Types of Brick Pavement Construction

In a recent inspection trip by A. T. Goldbeck and F. H. Jackson of the U. S. Bureau of Public Roads of a large number of brick roads in the Middle West, numerous modifications in design and interesting details of construction were observed. The following notes regarding these matters are abstracted from the report of Messrs. Goldbeck and Jackson as printed in Public Roads:

Method of Laying Brick on a Curve.—An interesting method of laying brick on a curve was observed on a monolithic brick road at Paris, Ill. By the scheme the use of small bats was eliminated by laying the course of longitudinal brick and the transverse courses extending to this longitudinal course in the form of saw teeth. The small bats were set not at the edge of the pavement, where they would be in more danger of being displaced, but at the inner end of the whole brick placed along the edge. This detail probably aids in preventing the edge of the pavement from being battered by steel-tired vehicles.

Radical Type of Construction Near Danville, Ill.—The Danville-Tilton road is of peculiar interest because of its radical type of construction. It is built on a concrete base with a sand-cement cushion and wire cut lug brick, laid on their sides with lugs down. Bituminous filler was used. The joints of this road do not seem to be well filled. The brick are chipping at the edges, and there are soft brick in spots. This road was built as an experiment about one year ago and its behavior is being watched with interest.

Brick Surface on Brick Base.—The base of the Danville-Batestown (Illinois) road was an old brick road made of building brick, sand-filled, and laid about 15 years ago. Under heavy traffic the old road had settled very badly, making an uneven pavement. This foundation was covered with a course of 1:2:3 concrete, using pea-size gravel. Just enough concrete was used to level off the base. Wire cut lug brick were set directly in the green concrete and then grouted. At one end of the road 3-in. brick were used and at the other end the brick were 4 in. thick. The resurfacing work was done about one year ago, and the road was in good condition when inspected.

Brick Surface on Thin Concrete Bases.—A short section of experimental road near Danville, Ill., was built of wire cut lug brick laid on 1, 2, and 3 in. of concrete, respectively. It was built in 1915, and since then subjected to heavy traffic. All of the sections are in uniformly good shape. There is no difference in their appearance. It might be pointed out that the idea of using so thin a base as 1 in. of concrete was simply to prevent the soil from being pushed up into the vertical joints in the brick, as well as to provide a bedding course upon which to lay them. More perfect grouting of the brick is thus insured. The same results probably would have been secured by the use of a 1 in. sand-cement bed.

The condition of this section brings out very forcibly the possibilities of light design for the monolithic construction when the conditions are favorable. In this, as in other cases of light construction sustaining heavy traffic, the underlying soil is of a character which permits good drainage so that it is possible to keep the foundation dry and thus maintain its bearing power. On the other hand, a soil such as the clay of Cuyahoga county, Ohio, which retains and attracts moisture through capillary action and is hard to drain, loses the greater part of the bearing power it would possess in a dry state. Light construction would obviously be poor engineering under such conditions.

An interesting feature in connection with this experimental road was the fact that a previous inspection made by the county engineer had shown that a monolithic bond existed between the base and the brick. He stated that he had occasion to take up a considerable area of this pavement after it had been under traffic for some time and that the brick adhered to the concrete very well.

Bricks Laid Longitudinally on Curve.—At Hoopeston, Ill., an interesting method was noted of laying brick on a curve on the Lincoln Highway. The brick were laid longitudinally around the curve, instead of transversely as in general practice. Close inspection of this curve showed no defects, indicating that this method of construction is satisfactory. This road is 2 years old and is subjected to fairly heavy traffic.

Brick Pavement on Macadam Base.—A section of the Lin-

[illegible] Ill., [illegible] grouted repressed brick [illegible] macadam base. Before the [illegible] was widened and there is [illegible] of the road causing fail[illegible]. This fact empha[illegible] out viz., that in [illegible] of the subgrade it must [illegible]. When additional broken stone [illegible] road it is a very dif[illegible] to the same degree of com[illegible] road. It is the opinion of the authors that it is advisable to plow up the old macadam base and reroll it over the entire width in order that it may be [illegible] evenly. There are [illegible] of this brick road. In general, however, the surface is in very good shape except [illegible]. These bad spots probably could be repaired satisfactorily by the application of bitumi[illegible]

[illegible] Pavement Without Edging.—The Lincoln Highway [illegible] construction with a [illegible] base. There is no edging of concrete at the sides of the road and no evidence of [illegible] only one year old but is in excellent condition. There are very few defects [illegible]. A defect was noted in the wearing surface of the road where it passes over a culvert. A concrete slab was used at this point and is very badly worn, making rather unpleasant riding. It would seem desirable in all cases of culvert construction to carry the road surfacing clear across the culvert and thereby make for more [illegible] good practice to reinforce [illegible] to culverts of this character.

[illegible] Base.—A [illegible] 16 ft. wide, constructed on a gravel base with a 1-in. cement-sand cushion and 4-in. wire-cut lug brick, is part of Indian Head Trail, north of Sterling, Ill. It was laid in the summer of 1917. There is moderate traffic, with occasional heavy loads. The surface is in excellent condition, with no indications of punching through of the brick or breaking down at the sides. There are some transverse cracks, but no longitudinal. Transverse cracks occur at about the same distance as in a concrete road. The subgrade is a fine black loam and is not provided with tile [illegible]

Brick Pavements at St. Louis, Mo.—Present practice in the construction of brick streets in the city of St. Louis makes no provision for expansion joints at street intersections. A number of semimonolithic brick streets using 1:3:6 concrete foundation and 1-in. sand-cement bed have been constructed recently along the above lines and no evidences of expansion failures at street intersections have as yet been noticed.

A semimonolithic brick street in which a type of expansion joint consisting of one course of wood block across the street every 10 ft. was observed. This road has a 6-in. concrete base, 1-in. sand-cement bed for part of the way, and limestone screenings for the rest of the distance, and 4-in. brick. The use of limestone screenings in place of sand in the cushion is an improvement over the old standard construction in that there is much less likelihood of the cushion pushing up into the joints when the brick are rolled. Subsequently a number of streets were built, using this construction.

The oldest brick street in St. Louis was observed on Euclid Ave. and found to be in good condition, although laid about 25 years ago. Traffic on this street, however, is not heavy at present. The joints are sand filled.

A brick intersection laid in December, 1915, on the north and south road as a demonstration of semimonolithic construction is in the form of a cross with three arms 200 ft. long and the other 360 ft. long. All but the outer 160 ft. of the long arm was built on a 4-in. concrete base, using 4-in. brick. The outer 160 ft. was laid on a 2-in. concrete base. The traffic on this road is very heavy and has caused a number of local failures, such as longitudinal cracks, transverse cracks, brick spalling at the joints, broken brick, etc. The surface is very badly broken up, a condition particularly noticeable at the extreme end of the section. An analysis of this failure indicates that it is due primarily to poor grouting combined with an inferior quality of brick. The appearance of the longitudinal crack would likewise indicate that some settlement had possibly taken place. This condition emphasizes very strongly the necessity of properly filling the joints in the brick with grout, thereby forming a truly monolithic surface. This undoubtedly would have protected the brick and to a certain extent would have prevented the breaking up which was observed. It was suggested at the time that a much better penetration of the grout would have been secured by the use of a modern machine grout mixer instead of the old-style box mixer which was used. This experiment clearly demonstrates what may be expected to happen to a brick pavement subjected to heavy traffic when all the details of construction are not very carefully observed.

Light Monolithic Brick Pavement. A pavement of this kind was inspected at North Alton, Ill. A short section of road 12 ft. wide was laid on the main highway leading north from Alton. The construction was 4-in. brick laid on a 2-in. 1:4 sand-cement bed, with no concrete base or edging. There appeared to be no evidences of foundation failure, in spite of the very light base. The condition of the brick and of the grouted joints was likewise good. This a very good example of the possibilities of light monolithic construction under favorable conditions of subsoil and drainage.

Experiences in France and England with Water-Bound and Bituminous Macadam

In a discussion at the recent conference of Road Superintendents and Engineers in Ontario, Mr. D. T. Black, City Engineer of Welland, Ont., gave the following information regarding English and French experiences with macadam:

The opinion in Great Britain and France is that if a simple water-bound macadam does not last two years without resurfacing, it should be changed to another type of construction or superficially tarred to increase its life if possible, to or beyond this period. English experience indicates that 120,000 tons of traffic per yard width will wear out the best water-bound macadam in a year, and when the traffic reaches 50,000 tons per yard width per annum or 135 tons a yard width per day, water-bound macadam should not be considered. The French estimates the traffic limit of water-bound macadam to be 1,000 "collars" a day for the whole width of the road. A "collar" is a single horse drawn vehicle, and an automobile is equivalent to three "collars."

The efficiency of bituminous macadam in England is well established by many examples which have been under hard wear for years, and a number of tar macadam roads have endured from 30 to 35 years with only occasional resurfacings. In Sheffield a tar macadam road with a traffic of 36,000 tons per yard width per annum has been in service for 22 years at an average cost, including the original expenditure, of 8 ct. per square yard. It is claimed that it can still be maintained for many years at an annual cost of 6 ct. per square yard. Many other bituminous pavements in Great Britain have been in use for long periods, and are still giving excellent service at very little maintenance cost.

The penetration method adopted in England much resembles the system generally used in Canada with the exception in some cases that the hot pitch softened with oil is hand poured and sometimes mixed with an equal part of hot sand. In France the penetration method is not much favored. The mixing method is, however, highly commended all over Europe, and although under different names, the system chiefly consists of heating granite, trap rock, hard limestone or slag, until all moisture is driven off and mixing it with hot tar at the same temperature, usually 225 to 350 degrees. The granite and trap rock mixture in most cases receives the sand filler, whereas slag, to which the tar or bitumen clings better and which is more readily compressed by roller and traffic, filling up the interstices, does not require such a filler.

Road Men Returning from France.—Wagon Companies 1, 2, 3, 4 and 5, Fourth Battalion 23d Engineers, have been ordered home. The return of this regiment along with certain battalions of the 41st, 42d and 43d, was requested in a resolution passed at a meeting of the American Road Builders' Association in New York City, Feb. 28, 1919, which authorized the President to appoint a committee to take up with the War Department the matter of returning these units. Mr. S. M. Williams, president, Highway Industries Association, was made chairman of the committee and has been working with the Secretary of Agriculture for the return of the road men in the regiments mentioned above.

Machine Finishing Concrete Roads*

By E. G. CARR,
Consulting Highway Engineer, The Lakewood Engineering Co., Cleveland

Concrete in roads is subjected to more severe conditions than are ordinarily encountered when it is used for other purposes—abrasion of the surface and the pounding effect of traffic which causes strains not common in other concrete structures. A continuous slab of concrete on country soil is also subject to expansion and contraction caused by changes in temperature and water absorption. Hence, concrete for roads must be better concrete. It must be more dense and uniform than for most other uses. A small amount of inferior concrete in a wall may be protected and supported by the stronger concrete surrounding it. In a road the traffic hunts out the weak spots, and these places will fail regardless of how good the surrounding concrete may be.

Top View—The tamping machine and uniform pavement attained with it. Center—Machine spreads, tamps and finishes the concrete. The tamper strikes ten times in its own width. Bottom—Concrete of this consistency makes stronger roads but would be very difficult to strike and finish by hand. The machine handles it easily.

Concrete cannot be compressed like a bale of cotton, and it can be compacted only by creating a flowing or crawling action in the concrete mass, so that the larger aggregate will settle closer together, and the smaller particles will fill the remaining voids.

There are three common ways of molding concrete to reduce voids. Two are detrimental and one beneficial to the strength of the product and all three generally are employed in varying degrees.

One way is to add excess water until the concrete literally flows in place by gravity. Another method is to use finer aggregate so that there will be less voids to fill. The third way is to stir it, tamp it, roll it, shake it or anything to move the more loosely arranged aggregate so that they will fall into closer and more compact position.

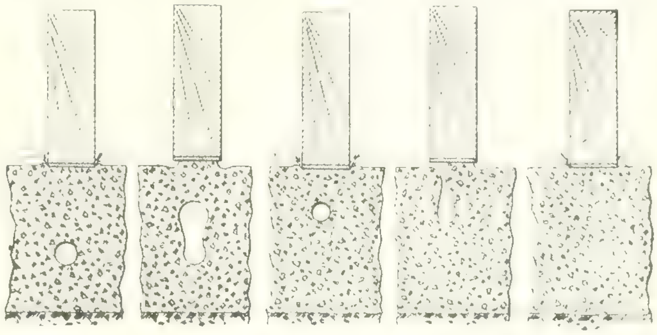
The use of excess water impairs the strength, makes the concrete porous and causes the lighter material to float to the top and cover the surface with laitance and foreign material, which may have found its way into the mixture. In some concrete structures there is an advantage in having the best concrete at the bottom, but it is evident that the best concrete should be at the top of a road.

Engineers have long known that an excess amount of water used in mixing will cause a considerable loss of strength in the concrete. Exactly what ratio exists between water content and strength has recently been shown by the extensive investigations of Professor D. A. Abrams of Lewis Institute, Chicago.

The use of too much water cannot be blamed unreservedly on the contractor because heretofore methods had not been developed for the practical use of stiff concrete for roads.

The size of the aggregate governs largely the amount of water needed to give a workable concrete. The smaller aggregate requires more water.

If a road were built of a rich mixture of cement and fine aggregate, the cost would be excessive and the expansion and contraction would be greater than if a mixture of fine and coarse aggregate had been used. Moreover, when a contraction crack forms in a concrete road, the coarse aggregate dovetails the slabs together, holding them in their original relative position.



Showing How Entrapped Air Is Removed From the Concrete by Alternating Pressure.

(1) Air compressed. (2) Air expanded in path of least resistance. (3) Air bubble again compressed nearer surface. (4) Air bubble breaking through surface. (5) Air bubble entirely removed.

The greater the proportion of good, clean stone, mixed in a given consistency of cement mortar without forming voids, the better the concrete will be for roads.

While concrete used for building roads presents more than the ordinary disadvantages to the use of excess water or fine aggregate, it offers exceptional opportunities for mechanical compacting on account of its accessibility.

The method of applying force in mechanical compacting must be such that the larger pieces will not be displaced after they have settled to their best relative positions. The applied force must not drive a stone past the best place for that stone to stop, and the only available means for stopping that stone at the right place is the increased resistance offered to the movement of the stone by a more compact mass than the mass in, and with which the stone is moving.

Assume that we have an agitating force with a limited violence or a tamper with a given stroke. A greater frequency of strokes enables us to make a stiffer concrete flow. It is this principle—the rapidity of agitation—which yields the unique advantage that mechanical tamping has over hand work.

Under a rapid succession of strokes, the concrete literally flows as a result of the agitation and the mass is in a semi-liquid condition. The drier and coarser the concrete, the less it will move under the influence of a single stroke, and the sooner it will be at rest again. To obtain the advantage of a moving friction, the succeeding stroke must come while the concrete is still in motion.

Voids in concrete are a source of weakness and, if beneath the surface, may not be detected until the raveling of the ag-

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*From a paper delivered in the Short Course in Highway Engineering, University of Illinois, Urbana, Ill.

[illegible] [illegible] [illegible] [illegible]. Therefore the effect of the agitation [illegible] [illegible] [illegible] and the [illegible] must be [illegible] [illegible] [illegible] is a reasonable certainty that the [illegible] [illegible] has been accomplished.

Starting with these [illegible], the [illegible] [illegible] the con[illegible] [illegible] [illegible] here.

After [illegible] [illegible], it was found to be exceptionally advantageous to [illegible] [illegible] for the purpose of agitating the concrete mass.

It [illegible] [illegible] in [illegible] [illegible] [illegible]. It will be noticed that the [illegible] [illegible] the [illegible] is easily [illegible] [illegible] while it is difficult to [illegible] [illegible] [illegible] in the [illegible] [illegible] [illegible] on account of the weight of the [illegible] [illegible]. [illegible] [illegible] that it would seem [illegible] [illegible] [illegible] [illegible] to it. Any additional pressure in the direction of the force of gravity tends to [illegible] [illegible] [illegible] [illegible] to the [illegible] assumed [illegible] [illegible] [illegible] [illegible] of facilitating any movement in the mass that would rearrange the aggregate into more compact positions. A keystone of an arch is not displaced by downward pressure upon it.

It was found that by [illegible] a vacuum above the concrete mass in one place, mortar was forced towards the vacuum space, [illegible] the [illegible] of the aggregate and permitting the [illegible] to settle into more compact positions, hitting the keystone from the bottom, so to speak. The idea can be well illustrated by a log jam. Force aplied to the up-stream side of the jam only wedges the mass more firmly, it would be readily broken by pressure applied below the jam by a reversal of the current.

In the machine illustrated, the suction is obtained by the tamper templet, which is raised with a jerk after hitting the concrete, alternately driving the concrete away and jerking it back. This action removes the entraped air, giving a dense concrete.

The machine illustrated is so constructed that the speed, length and intensity of the strokes can be varied at the will of the operator to meet all the different consistencies of concrete and conditions found in road work.

A laborer tamping concrete, would pass over the surface if it appeared finished. The machine tamps thoroughly and uniformly. As it works forward and backward, it attacks a bad arrangement of aggregate, first from one direction and then from the other, insuring a slab of uniform density.

Besides the advantage ot more thoroughly and uniformly compacted concrete, machine finishing is a more dependable means of obtaining a true, even surface, thereby reducing the vibration and wear on the pavement and vehicles.

Federal Aid Road Construction

In the April 26 Bulletin the Highway Industries Association calls attention to the fact that at the present rate of progress in Federal Aid road construction it will take 29 years to use up the allotment of $77,600,000 that will be available on July 1, 1919. On Feb. 21st, 1919, states the bulletin, a total of 841 projects had been approved by the Secretary of Agriculture, calling for the improvement of 8,615 miles of roads. This approval was of the general outlay and not of the plans and specifications made after careful surveys and plans had been completed. The total number of projects approved as given above, after having plans and specifications submitted amounted to 431, approximately 50 per cent of the total number submitted by the states. On Jan. 1, 1919, only 316 of these 841 projects submitted had been placed actually under construction or completed, being only 37½ per cent of the gross number applied for. The 316 projects under construction on Jan. 31st involved an outlay from the Federal Aid Fund of $8,382,067. There had been completed and accepted on Jan. 1, 1919, about 50 miles of Federal Aid Roads, and the gross amount that had been paid out by the treasurer on the warrants drawn by the Secretary of Agriculture for all work under the Federal Aid Act, as shown in the report of the Secretary of Agriculture of Nov. 15th, was about $424,445, and it is estimated that an amount not exceding $2,000,000 will have been expended from this fund by July 1, 1919. There will be available to the states on that date $77,600,000. At this rate of expenditure of approximately $2,000,000 in two years, $1,000,000 per year, it can be readily seen that at the present progress being made in Federal Aid construction it will take 77 years before the states use up their allotment available on July 1, 1919.

Motor Truck Haulage Saves About $1,000 Per Mile in Gravel Road Construction

A saving of about $6,000 was effected by Itasca county, Minnesota, in the construction of 6 miles of gravel road by employing motor trucks instead of teams for hauling the gravel. The work was done on the Grand Rapids-Duluth Highway in August to November, 1918. The following equipment was used:

	Cost.
[illegible] motor trucks, 5 yd. capacity	$11,966
[illegible] motor trucks, 3 yd. capacity	11,116
[illegible] gravel screening plant	1,790

The 5 yd. trucks are of the same manufacture and chain driven; the others are all of different makes, with worm drive. The gravel screening plant is of the bucket chain type with revolving screen and bin of 15 yd. capacity.

The gravel was slushed by teams into a hopper from whence it was elevated and screened, the power being furnished by a 7 h.p. gasoline motor encased in a housing under the bin. The capacity of this plant was a maximum of 175 cu. yd. per 10-hour day. The gravel in this pit is clean and well graded, containing only a small amount of oversize rock or tailings. It was easily slushed without blasting or picking, one team sometimes moving as much as 70 yd. a day.

Motor Truck Outfit of Itasca County, Minnesota.

The roadbed is a sandy soil, with a small percentage of clay, which would not stand up under the trucking; therefore the graveling was started from the pit end and continued progressively towards the other end, gradually increasing the length of haul. It had been planned to start the graveling at intermediate points so as to have about the same average haul in order to not bunch the trucks. It was found impossible to do this because the subgrade would not carry the trucking.

The gravel being slow packing, it was found necessary to deposit it in thin layers of about 400 yds. to the mile. A thicker layer made the trucking more difficult and took a longer time to consolidate. The first layer was churned up with the sand and nearly lost to sight, but served to make a foundation for the trucks to haul over. The second layer reinforced this foundation and the third finished the surfacing as far as it was proceeded with last season. It will be necessary, however, to use about 1,000 yd. per mile additional before the job is accepted as completed. Thus, when finished, there will have been used approximately 2,200 cu. yd. of gravel to the mile.

Work was discontinued on the last day of November, as the trucks could no longer be operated economically on account of snow and cold. It was not considered a practicable proposition to continue the work throughout the winter, judging from the results obtained the last week in November.

The total cost of the work amounted to $12,500, distributed as follows:

Hauling (average haul, 3 miles), 7,200 cu. yd. at 50[illegible]	$3,6[illegible]
Repairs to trucks	7[illegible]5
Repairs to gravel loader	[illegible]20
Depreciation and interest on equipment	3,[illegible]6
Garage charges	2[illegible]
Overhauling trucks on completion of work	155
Gravel loading, 7,200 cu. yd. at 25 ct	1,800
Grading 2,000 cu. yd. at 45 ct	900
Stripping gravel pit, 1,000 cu. yd. at 35 ct	350
Construction and equipment of camps	550
Construction [illegible]	3[illegible]

Figuring in all expenses for operation of trucks it was found that the cost of hauling, average length of haul being

3 miles, was $1.15. If the hauling had been done by teams the cost would have been very near to $2 per yard. It is thus easily figured that the saving on this job, by using trucks instead of teams, was approximately $6,000.

The finishing of this job will be resumed at an early date, and it is also planned to extend the graveling 3 miles farther to the county line, so that the longest haul will be about 10 miles. The work was carried out under the direction of O. J. Lidberg, County Superintendent of Highways.

Experiences of California Highway Commission With 4 in. Concrete Bases

At the end of 1918 the California Highway Commission had constructed over 1,000 miles of concrete base road of which more than 600 miles had been covered with thin bituminous tops or carpets. Most of these concrete bases are from 4 in. to 4½ in. in thickness. The experiences of the Commission with these thin concrete bases is summarized as follows in their report for the year ending Dec. 31, 1918:

It has always been the plan ultimately to cover the concrete with bituminous material but for the 2 years past little of such surfacing has been done. It was recognized early that the second bond issue would fall far short of completing the roads contemplated and the bituminous top was one item which could be omitted, temporarily at least.

It must be admitted that a concrete base so thin as 4 ins. would not be at all suitable in localities where the frost penetrates deeply into the ground and nowhere in California has concrete been laid under such conditions.

It must also be admitted that experience has shown that over adobe subgrade it is not wise to lay so thin a base unless it is reinforced with steel. Even with such reinforcement longitudinal cracks develop which widen year by year despite frequent filling with asphalt, and a weakened pavement results. The reinforcement, without the use of more steel than seems justifiable, will not prevent the longitudinal cracks but it appears to hold the concrete together and in some measure to lessen the progressive widening of the cracks. Increasing the thickness of the concrete per se does not remedy the longitudinal crack difficulty.

The thin bases have given admirable service and have proved their economy under California conditions of climate and traffic whenever the underlying subgrade has been firm and hard and the concrete has remained in contact with the subgrade.

It is true that in some localities the concrete has broken and disintegrated under the traffic but such cases are so rare as to be almost negligible in considering the whole system.

Sometimes this has been the result, beyond doubt, of a thinner pavement than was specified due to the carelessness of the contractor and not noticed by the inspecting engineer. Sometimes the concrete mixture was defective due to the absence of sufficient cement or to insufficient mixing or to the use of dirty aggregates. These things happen in all construction work but in considering the whole system, such lapses are very exceptional.

In the northern part of the Sacramento Valley a new difficulty presents iself in the rapidly increasing use of the land for rice culture. This sort of farming requires extraordinary quantities of water. The natural drainage channels are blocked by rice checks and the water stands in the borrow pits along the road and the subgrade under the concrete pavement is saturated and remains so for long periods. In places, where the water is drained from the fields, it backs up so as to cover the pavement.

A subgrade so saturated will not sustain the 4-in. base with the heavy traffic and the pavement cracks and disintegrates.

Recently much trouble has been experienced between Williams, in Colusa County and Willows, in Glenn County. In November and December of this year the state highway has been damaged seriously by motor trucks hauling rice. The sacked rice, according to a report of the division engineer, is brought from the fields with teams and stacked on the roadsides along the state highway. It is here picked up by 2½ to 5 ton trucks, which never leave the pavement, and are thus enabled to carry excessive loads. In some cases the rice is loaded with a bucket elevator or stacker, which piles the rice high on the rear end, thus concentrating 90 per cent to 95 per cent of the load on the rear wheels.

Contour Method of Relocating Roads

There are various types of road relocations, the "contour relocation" being perhaps the most widely used. The old system of laying out roads to follow stream lines until the head of the valley is reached and then making the steep hard climb to gain the summit is fast being replaced by the contour grade development. This, briefly stated, consists in making the ascent by a long easy grade line, which develops a sufficient distance to attain the desired elevation. An interesting discussion of the methods used in these relocations is given by Mr. Gordon F. Daggett, Engineer of Surveys, Wisconsin Highway Commission, in the April issue of The Wisconsin Engineer, from which the notes that follow are taken.

Contour relocations are those wherein grade and alignment are developed by using the actual contour intervals as they exist on the ground. In a great number of cases, the relocation is virtually in sight, but ofttimes a careful study of the ground is required to find the general direction of such a relocation. The height and approximate length of the hill to be relocated must first be determined. The grade desired is generally controlled by traffic and physical features, such as slope, drainage, materials encountered, etc. A decision having been reached as to the desired grade, the next step is to run out the grade contour. The contour must be actually established in the field by a level party, which generally consists of three or five men. The levelman through his rodman, sets each point on the desired contour at the station points. For instance, if a 6 per cent grade contour is being laid out, each point on the line will be exactly 6 ft. above or below the last point, depending upon the direction of running, and 100 ft. distant therefrom.

Experience shows that the fastest and cheapest lines are obtained where the line is started at the top of the hill and run down. The reason is that less trouble is encountered, and more time saved by reason of the fact that the rodman is better able to judge the required interval.

It oft-times happens that there are two or more possible locations in sight, and engineers should make a reconnaissance of each of the possible routes, and after comparing them, have the survey run on the route that seems to be the most feasible. If, however, more than one route opens a possibility, the survey should be made and plans worked up to such a point that comparative estimates can be drawn.

After completing the grade contour, a location or transit line should be run for the purpose of obtaining the exact location of each point on the line. This transit line need not follow the actual contour, but may consist of reasonably long tangents with offsets to each station point on the contour. If the contour follows along the side of a rather sharp, steep slope the transit line should follow the actual contour with angle points at each station. Following the transit party is a level party cross-sectioning the line. The cross-sections in some instances are taken with a Locke level, but in general, if the difference in elevation is not too great, sections are taken with an engineer's level. A sufficient number of cross-sections should be taken to enable the engineer properly to make his preliminary studies and estimates. The soil classification should be noted at the time of taking the cross-sections.

Upon completion of the field work, the necessary plans are prepared. These plans should show in detail: (1) the plan and profile of the old road that is being relocated; (2) the proposed relocation; (3) a contour sheet upon which can be developed the necessary studies; (4) the projected location; (5) the final location as selected in the office. The projected location is made by taking into consideration grades, drainage and general alignment.

Sharp curves (which cannot always be avoided) should have a compensated grade, as in railroad design. For instance, one relocation in Richland County has 4,000 ft. of 7 per cent grade, but in the center of this grade it was necessary to make a "hairpin" curve of a 105 ft. radius through a central angle of 185°. The grade was reduced to 4 per cent for a distance of 350 ft. on the curve.

The matter of the movement of excavated material is all important. The length of haul must be kept to a minimum.

[illegible] will save con [illegible] possibly lengthen the [illegible] of way required. Even [illegible] than to move material [illegible] be well to call atten [illegible] study the project thor [illegible] they have the most [illegible] highway engineer, being [illegible] feel somewhat touchy on [illegible] question "How do you [illegible] best line obtainable?" Men [illegible] merely in the feeling [illegible] best that could be [illegible] of an engineering [illegible] and to prove it all facts [illegible] comparison. Too often the [illegible] than an engineer who does [illegible] is not worthy of his [illegible] The best engineer is the one who devotes to his problem all the study that time [illegible] his final selection until he [illegible] economical line has [illegible] On a 4700 ft relocation that was recently completed southwest of Richland Center, Wisconsin, five different lines were projected. Three of these lines were almost identical in alignment; but a slight difference in the material distribution, or shift in grade made each new line appear to better advantage than the previous one. The line finally selected involved a study approximating forty hours in the office. Another relocation [illegible] a study of about 70 hours for 1½ miles of highway.

The handling and balancing of material is a problem that consists of more than merely establishing a grade line and borrowing or wasting the excess material. An effort must be made to secure the most economical line, using the yardage available from actual cuts. It will be admitted that there are cases where borrow or waste of material is a necessity, but on highway work, this can usually be avoided. A waste dump is unsightly, and a borrow pit is many times a sump hole for drainage. Plans for relocations often show that practically no study of this phase of the subject has been made.

The last step is to stake out the final projected line in the field. This is done by a transit party, and all the station points, fences, streams, ravines, rock out-crops, soil conditions, buildings and other features of vital interest to the project are again noted in the field book, this time with reference to the final line. The final line is then recross-sectioned for a width sufficient to cover all yardage work. Final estimates together with the necessary plans and profiles for construction can then be prepared.

Right of way should always be definitely arranged for before allowing any construction work to begin. Easements should be secured and filed, thereby eliminating possible troubles when the construction work is in progress.

An engineer who has to buy right of way, must have a world of diplomacy and tact, must know his business and must always be ready to look at the matter from all standpoints. The majority of property owners are reasonable and easy to deal with if properly approached in the beginning. They will, of course, demand to know why the selected location was chosen, as against some other location, and it is only right that the entire matter should be explained to them in detail. They are the ones primarily affected. Oft-times it is necessary to cut a farm into small irregular shaped parcels of land that can be cultivated only at a loss. In these cases it is cheaper to "pay the owner's price" than law the matter out in the courts. Pay double the value of the land, if by so doing the good will of the party can be retained. It is not best to condemn private property except as a matter of last resort, as it is not only expensive, but always creates and leaves hard feelings with some one.

To reduce future maintenance, the proper location of a road is of prime importance. Plan the road to go around the hills rather than over them. It is next to impossible to carry water down a long steep hill for its entire length, without soon causing damage to the road, while if it is planned to go around or along the side of the hill, the water can easily be transferred from the upper road ditch to the lower one and immediately diverted from the road to its natural channel by the use of the proper culverts.

Contour grades usually involve a side-hill section, being partly in cut and partly on fill. Care must be taken, therefore, to estimate the shrinkage or swell of the material handled. The question of correctly estimating this shrinkage or swell of the material is one that invites more or less discussion. There is only one safe rule to follow, and that is to make the estimates according to experience with the class of material to be handled.

Cut and fill will vary with the local material and conditions, but generally speaking, cuts will have a slope of 1 to 1, and fills a slope of 1½ to 1. In one instance the banks in a long, deep side-hill cut began to slough off, and there was no apparent cause to be found. The banks were trimmed back twice without success and finally it was decided to cut them back to a 1¾ to 1 slope, which solved the problem. The material was loose rock and clay, containing some sand, but no water.

Combination Body Adapts Trucks to Many Uses

An excellent example of the adaptability of a truck to many different kinds of work is given by the Federal delivered recently to Mr. Chas. S. Wheeler of McCloud, Calif. The demands of the owner were to design a combination express body, dump body, which was to be removable, so that the flat bed of the truck could be used for hauling large and cumbersome commodities upon the large estate of the owner. The express or delivery body equipped with a drop tail gate is zinc plated, steel lined and constructed to be leak-proof and is readily adaptable for loose materials such as sand, gravel, etc., or for the purpose of hauling merchandise. The body is so constructed that during a demonstration given a few days ago, it was removed from the chassis and rolled upon a special built receiving stand in less than 4 minutes. The frame of the truck is equipped with rollers so that the body can easily be slid off and truck chassis onto the receiving stand by two men. When the body has been removed from the truck chassis the specially constructed flat bed can be used to haul logs or other large and cumbersome articles that it would otherwise not be possible to handle. One of the most novel features of this specially designed truck is that when the body is removed, the under body is equipped with rollers and skid sockets on either side and rear end to permit of the handling of heavy materials which are rolled or skidded over these rollers to loader position on the truck. The heavy materials, such as logs, etc., are automatically lifted or drawn into place on the truck by its own motive power through the use of the hoist cables operating from the motor. The truck can also be used for road work, being equipped with a special hydraulic hoist raising the body of an elevated dump body position permitting loose materials used for road work to be easily slid out of the dump body and spread. The acquisition of the specially double acting tail gate which consists of a drop tail gate into which has been built another gate that is used for spreading when the body is elevated for dumping purposes, is likewise a novel and unusual feature. The latter gate is operated from the driver's seat. The truck is likewise equipped with a specially designed spring draw bar for tractor use eliminating the undue shock and stress upon the truck when used with trailer.

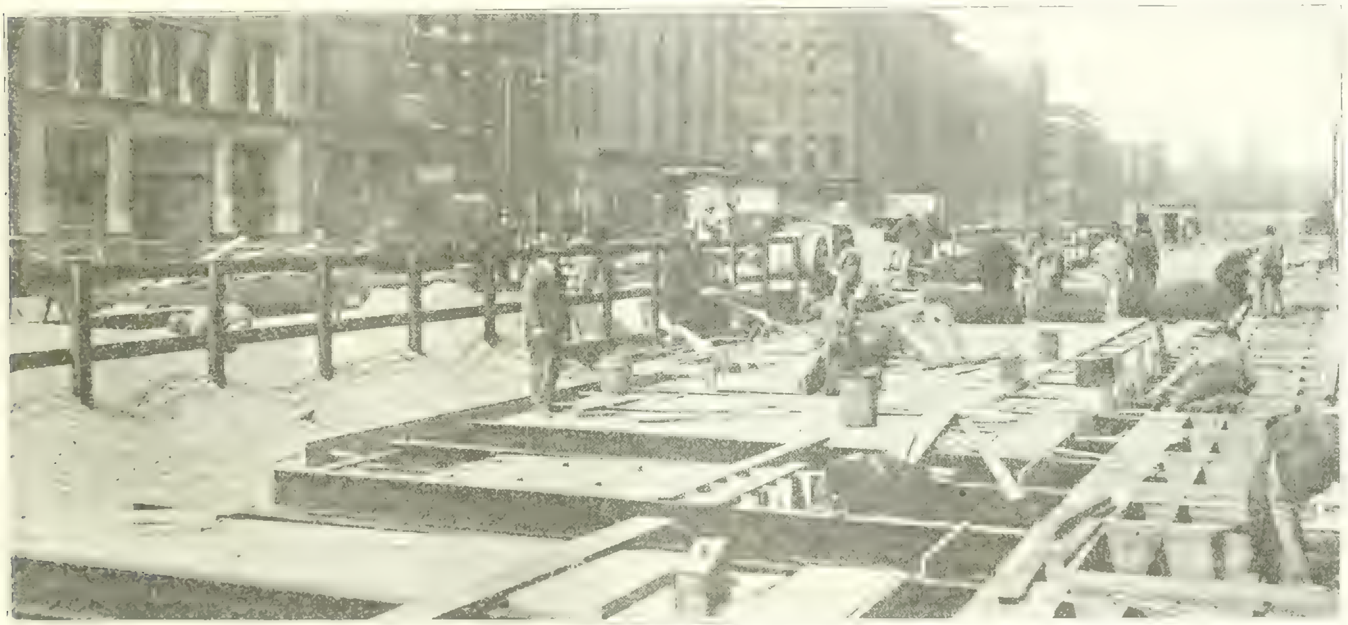
Federal Truck with Specially Designed Combination Body.

Sidewalk Construction for New Boulevard Link, Chicago

Chicago is now replacing the weak link in its comprehensive boulevard system. This is the stretch of Michigan Ave. and Rush St. between Randolph St. and Chicago Ave., where for years traffic has been compelled to go through narrow confines and where almost inextricable jams have frequently occurred.

The remedy for this will be the so-called Boulevard Link, which has been talked of for years, but which is just now beginning to be worked out in actuality. This provides an elevated boulevard from Chicago Ave. down to Randolph St. for automobile traffic, with a lower level of somewhat shorter length for teaming. Both highways will be carried over the Chicago River by means of a double-deck bascule bridge.

The preliminaries of all this work are now under way, including the relocation of utilities, the removal of such structures as are in the way of the proposed improvement, the proper safeguarding of others, which are to remain, the concreting of the abutments and counterweight pits for the bascule bridge, and, as illustrated in the accompanying photographs, the laying of concrete walks on the new level and in front of some of the new buildings which have been erected.



Concreting Outfit and Form Work for Sidewalks for Michigan Avenue Boulevard Link.

The sidewalk work is of particular interest because it is being done very efficiently under the severe restrictions imposed upon the contractors, Rawson & Green, 6422 Cottage Grove Ave., Chicago. Practically all traffic northbound from the business district of Chicago going over this route; and while some effort has been made to divert a part of it to other channels, most of it still insists on taking the familiar trail, up past the site of old Fort Dearborn. This means that the contractors have been able to pre-empt only a scant 10 ft. of the roadway in which to store materials and carry on the work of preparing the concrete.

This has called for the reduction of the equipment to the simplest terms consistent with efficiency, a well-planned layout; and a co-ordination of efforts, so that, while there is little room for the storage of materials, they will arrive at such regular intervals that the mixer can be run continuously.

A rough wooden fence surrounds the work, inside of which the carpenters can handle the form work without interruption. At an opening in this fence a "Standard," low-charging mixer of ⅓-yd. capacity is located.

Starting at the mixer as the central feature of the outfit, the cement is piled so that it can be taken from the pile by the man on the charging platform and emptied directly into the mixer. This man also handles the water, which comes through a protected hose from a hydrant on the opposite side of the street.

Close to the mixer on the other side is the sand, and just beyond it is the gravel. These are brought in by motor trucks with end-dumping bodies, so that by properly spotting the trucks the materials can be delivered very close to the fence and take up as little space as possible. The sand and gravel are taken by wheelbarrows up the slight incline to the mixer and dumped directly into the hopper by the wheelbarrow men.

It would at first seem that the contractor had missed one point of efficiency by locating the gravel, of which he uses twice as much as the sand, farthest from the mixer. But he thought beyond that and remembered that wet sand—and it is sure to be wet this time of the year—weighs the heaviest, so that it should have the shortest run in order to equalize the burden on the wheelbarrow men. The crushed granite for top coat, of which a comparatively small amount is required, is placed in a less advantageous position on the other side of the mixer.

The crew is made up as follows:

2 men wheeling gravel
1 man wheeling sand
1 man on cement and water
3 men hauling away with wheelbarrows
men tamping and leveling
2 finishers
1 man cleaning up after carpenters
2 men placing steel

The sidewalks being built consist of 5¼-in. concrete slabs, built up over 12-in. steel I-beams placed on 5-ft. centers, the slabs reinforced with a sheet of No. 0-68 triangle steel mesh. The I-beams run from supports at the building line to others at the curb, and are wrapped with wire mesh to provide a proper bond for the concrete which encases them.

The basis of the form system is a standard inverted box section wide enough to fit in between the I-beams and allow sufficient space for pouring the encasing concrete. These sections are made in lengths to suit the lumber on hand and are then cut into such lengths as the work may demand. No standard length can be used, as a large number of utilities have to be provided for, making necessary many openings and other irregularities. No struts of any kind are used to support the form work. The form boxes rest on supports at curb and building line, and upon boards suspended by heavy wire stirrups from the I-beams. These boards supply the form for the bottom of the beam, and in removing the entire system of forms it is only necessary to take away these boards by disconnecting them from the stirrups which hold them, and the whole form structure can be loosened from the concrete and taken away.

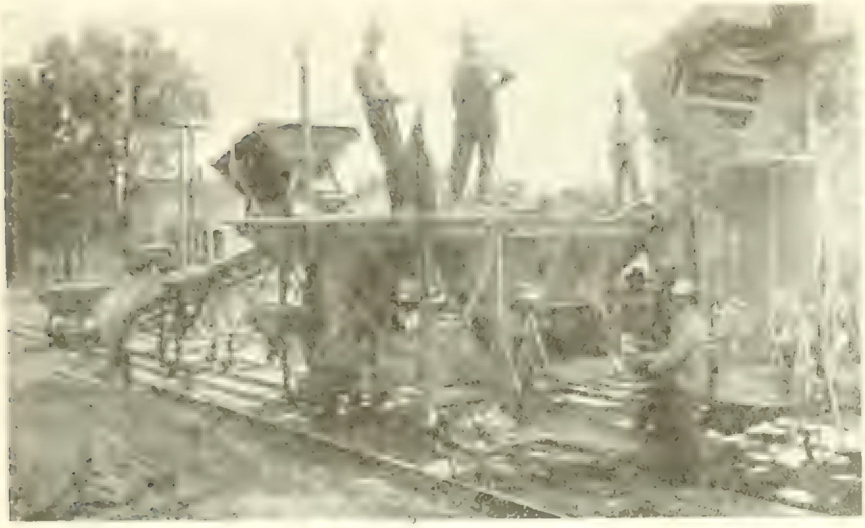
Expansion joints are placed at intervals of about 150 ft. At the point where an expansion joint is to occur, two I-beams are placed instead of one, with a space of a few inches between them. On to the top of each of these is bolted an angle iron, its length equal to the width of the sidewalk, and the vertical leg of which is cut to the slope of the finished walk. One of these angles has a narrow plate member and the other a wide one, so that the faces of the upright mem-

[illegible] They [illegible] expansion and contraction.

[illegible]

Labor-Saving Equipment for Handling Concrete Materials

[illegible] around the mixer [illegible] considerable [illegible] of the gang [illegible] concrete road [illegible] cement [illegible] in by teams [illegible] nearly cor- [illegible] piles sand [illegible] and dumped into [illegible] distribute material [illegible] or too little, the [illegible] the board and



[illegible] Measuring Devices for Proportioning Aggregates and Cement Measuring Drum for Aggregates and Measuring Box for Cement Delivering Correctly Proportioned Materials to Mixer Skip.

wasted, or in case of a shortage, wheeling distance is in- [illegible] as to [illegible] hold up the mixer.

In an attempt to eliminate many of these difficulties the R. D. Baker Co., Contractors, Detroit, Mich., developed a charging bin, materials being dumped directly into the bin and from there to a measuring device into the mixer hopper. The arrangement is described by Mr. Baker in the March Concrete Highway Magazine, to which we are indebted for the matter in our article.

The method of charging was worked out with the idea of hauling materials from the yards to the mixer by standard equipment, namely, 1½-yd. industrial cars and track, with any type of locomotive capable of delivering the quantity required. Also, it was planned to have a supply of materials on hand to avoid stopping the mixer through delay to the supply train, and, to develop a method of measuring materials while charging the hopper that would give batches at required intervals.

An accompanying illustration shows a charging bin used in connection with work on the Dixie Highway, north of Flint, Mich. This has proved the best addition the R. D. Baker Co. has made to its equipment from the standpoint of efficiency and economy. The main bin is built of sheet metal divided into two compartments, holding 5 cu. yd. of stone and 3 cu. yd. of sand, respectively. It tapers on all sides toward a rectangular discharge opening at the bottom. Here the materials run into a measuring device consisting of a cylinder divided into four quadrants or sectors, each being partitioned off in proportion to the mix.

The one illustrated holds 4 cu. ft. of sand and 6 cu. ft. of pebbles or broken stone, the mix on this job being 1:2:3. The cylindrical measuring device rotates on a shaft and is held in position by two spring dogs operated by a hand lever. The section to be filled comes to a stop under the rectangular discharge opening a little beyond the vertical position. Hence through the action of gravity, the cylinder rotates automatically on releasing the dogs and another empty section comes into position for filling. At one side the framework is extended to carry a bin provided for cement. Special car bodies were made to carry cement from the yard. These were provided with a bottom dumping device and were completely covered to protect contents from the rain. Each car held 10 bbl. of cement in bulk. The bin slopes on each side to a square opening, the operation of which is controlled by a lever. Under this outlet is a metal box holding 1 cu. ft. of cement. This is suspended just above the center on two trunnions carried on the end of a lever that swings horizontally. When the cement is to be placed in the mixer, the cement dumper swings the box over the hopper by operating a lever, and pulls a small chain to dump it. On release of the chain the box resumes an upright position and is swung back and quickly refilled. These bins are a complete unit that can be quickly detached from the supporting framework for shipment, but for moving on the job, the whole is mounted on traction wheels. The framework is made up in complete units carried by wheels running on industrial track. The incline, up which industrial cars are hauled, is made in two sections and arranged to allow for variations in the track over a hill.

Filling of the bins is accomplished by four men—one takes care of the cement, two the other materials, and the fourth the hoisting. There are two independent inclines to the top of the bins, and between the rails of each is a plank. A rope is attached to the car, and before it is started up the incline a sharp dog is hooked onto the rear axle and allowed to drag. This is simply a "safety first" measure, as should the car break away, the dog would stick into the plank and stop it.

Power for hoisting is obtained from a spool geared to the mixer engine, the operator taking about four turns of the rope around it. It is geared so slowly that it does not draw heavily enough on the engine to interfere with the operation of the mixer.

The particular merits of this equipment as tried out on a paving contract at Mt. Morris, Genesee County, Michigan, were as follows: No more men were required to dump the materials into the bins than to dump on the subgrade, shovel up materials, shift track and pile cement along the roadway. In dumping into bins no material is wasted and there is no hold-up through improper distribution of materials. Materials are kept absolutely clean. Cement is stored at the yard where cars are filled. No cement is lost by exposure to weather, as often happens when piled along the grade. No sacks are lost or wet and the usual work required to gather and take care of them is eliminated. Fewer men required in the mixer gang lessens the chance of being held up by labor shortage. Much of the hard labor is eliminated. Condition of the subgrade does not interfere with continuous operation. A very important feature is accuracy in measurement of materials and the personal factor of the shoveler is eliminated.

Cost of Street Cleaning at Columbus, O.—Operating expenses of the Division of Street Cleaning of Columbus for 1918 were 24.8 per cent greater than for the previous year. This increase was due to advances in wages and increased cost of materials and supplies. The average cost of machine cleaning was 33.5 ct. per great square, an increase of 6.1 ct. over the figures for 1917. The average cost of hand patrol work in 1918 was 40.6 ct. per great square, which is about 8 ct. higher than in the previous year. The average cost of hand cleaning was 77 ct. per great square. This method was employed for central alleys where traffic conditions are congested. The cost of car flushing averages 56.4 ct. per great square, an increase of 15.1 ct. over the previous year.

Method of Maintaining Michigan State Reward Roads

In the biennial report of the Frank F. Rogers, State Highway Commission of Michigan, for the year ending June 30, 1918, Mr. L. H. Neilsen, State Maintenance Engineer, outlines as follows the methods employed for state reward road maintenance:

All weeds within the right-of-way limits must be cut and burned or removed.

The shoulders must be mowed as often as may be necessary to indicate clearly the exact width of the grade and so that the culvert headwalls are always visible.

All brush within the right-of-way limits, except such as may be preserved for ornamental purposes or for shade, must be cut and burned or removed. All brush on the inside of curves must be cut so as to give a clear line of sight for at least 300 ft. Overhanging branches of trees must be trimmed so as to give a clear line of sight.

Guard rails must be kept repaired and painted. A coat of whitewash for culvert headwalls is to be recommended.

Culverts must be kept open and repaired, road ditches cleaned as often as may be necessary to insure a free flow of water, and outlets to road ditches must be kept working.

Driveway culverts must be inspected frequently and kept in good order.

In loose sandy soil which does not readily grass over, sods must be placed on shoulders and on the slopes of cuts and fills.

Ditches that are being gullied out must be protected.

A maintenance system approved by the State Highway Commissioner must be provided for. In counties operating under the county road system the maintenance of old state rewarded roads must be in charge of a responsible head. The County Superintendent or County Engineer may act as superintendent of maintenance or some one may be appointed to have entire charge of maintenance work.

Gravel Roads.—Wherever the contiguous mileage is sufficient to keep a patrolman busy, one must be engaged.

The patrolman may be equiped as may seem best. A wheelbarrow patrol would require a wheelbarrow, pick, shovel, rake, scythe, brush, hook or axe, etc. Gravel would then be stocked in piles about 500 ft. apart. Floating would be done by teams, motor trucks or tractors.

A one-horse patrol would be furnished with a light wooden road float in addition to the small tools, but would not need a wheelbarrow. He would be expected to furnish his own horse and light wagon. The gravel could be placed in larger piles and at greater distance apart.

A team patrol would be furnished with a heavier road float, and the small tools. He might haul his own repair gravel from the pit or from the railroad siding.

Material used for repairs must generally be of the same kind as that of which the road was built.

Where roads were built of screened or high test gravel, automobile traffic soon removes the filler material. For such roads, maintenance gravel with a maximum size of ½ in to ¾ in., and testing in the neighborhood of 60 per cent, would be preferable for use in small amounts on the surface. Holes or deep ruts should be patched with the same gravel used in the construction of the road.

Roads maintained under the patrol system must be gone over periodically with a road plane or four-wheeled grader to supplement the work of the ordinary road drag.

Gravel to the amount of at least twenty yards to the mile must be delivered and compactly piled at some accessible point or points along each improved road. A separate pile shall be placed on each disconnected piece and not more than enough for three miles shall be placed in one pile. In no case shall the gravel be placed so that it is necessary to drive over an improved piece of highway to reach the road. Suitable gravel must be hauled out of the pit and placed along the highway even though the pit is on the improved road.

Waterbound Macadam.—The patrol system of maintenance must be used to maintain the surface as far as the patching is concerned. Such roads are never floated. It is usually necessary to protect such a surface from damage by fast moving motor-driven vehicles by placing a covering on it. Two ways of doing this are recommended. Neither of these methods shall be used without consulting a representative of the State Highway Department as to the fitness of the surface for such treatment and as to the suitability of the material which it is proposed to use. Detailed instructions for doing such work will gladly be given upon request.

(1) Placing on the surface ½ in to 1 in of clay gravel testing 60 per cent or less or hardpan (a natural sand clay mix, preferably containing a little gravel). This forms a cushion and prevents ravelling. When so covered a macadam surface can be floated and patched and in general maintained in a manner similar to a gravel surface.

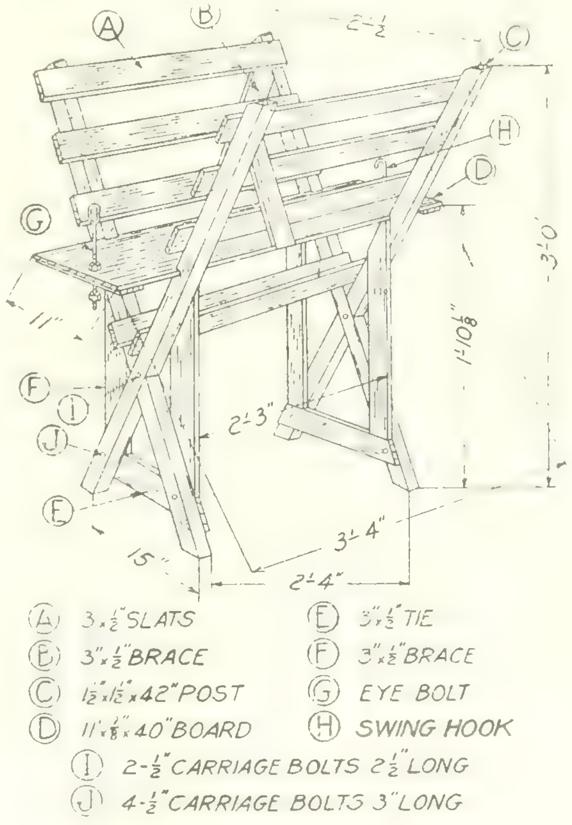
(2) By applying a bituminous surface treatment.

After such treatment has been given a patrol system must be installed to keep holes and ruts at a minimum.

Pavements.—Maintenance of cement concrete, asphaltic concrete and brick roads is best handled by gangs. One gang to go over the roads at intervals making the necessary repairs to the pavement itself, and another gang attending to such other work as may be needed. On very heavy traveled pavements patrol maintenance may be needed on shoulder work.

Cement Sack Bundling Device

The accompanying sketch, reproduced from the Concrete Highway Magazine, shows an inexpensive sack bundling device that con be made readily by any contractor. Fifty sacks are counted into the rack with two wires running under the pile and one long wire running lengthwise on top of it. One end of the steel bar is run through an eye bolt and attached to the other end to a hook. The two short wires are then tied over the sacks, thus doubling them over the long wire. The bundle is then released by withdrawing the bar, after which the long wire is brought around the ends and a hitch taken with it around the other wires. The long wire is then brought around the middle of the sacks and tightly tied.



Sack Bundling Device.

California to Vote on $40,000,000 Road Bond Issue.—The state of California will submit to its voters on July 1, 1919, a propsal for a new bond issue of $40,000,000 to provide funds for the extension of the pavements on the State Highway System. In 1910 the state authorized an issue of $15,000,000 and a second issue of $18,000,000 in 1915. Among the new projects the citizens desire to undertake are the Kerns River Highway, the road from San Diego to Yuma, Ariz., and a concrete boulevard 100 ft. wide from Merced to the Yosemite Park through El Portal.

Comparison of Truck Rates and Freight Rates on Short Hauls

[illegible] New York are much less than the [illegible] for corresponding distances, according to figures compiled by Mr. W. J. L. [illegible] traffic manager of the [illegible] and printed in The Commercial [illegible].

[illegible] out the economies of motor truck transportation [illegible] within [illegible] miles of New York City, Mr. [illegible] that [illegible] figure that [illegible] per 100 lb. via freight and the [illegible] truck [illegible] ct. that this in [illegible] an increased [illegible] cost of [illegible] ct. per 100 lb. This [illegible] is not a fair comparison and is not a true cost. Instead a transportation cost is all expense in[illegible] with the boxing or packing expenses and all other expenses incurred until delivery is made to the receiver in good order. The figures [illegible] in the accompanying table are worked out on an average basis, and while substantially correct they may not cover [illegible] the freight cost is the first class rate plus 15 ct. per 100 lb. teaming charges from the shipper's warehouse to freight house, plus 15 ct. per 100 lb. teaming charges from freight house to receiver's warehouse, plus 24 ct. per 100 lb. increased cost of boxing to cover shipments made via freight, plus 17 per cent account of increased weight caused by increased cost of boxing. The rate via motor truck covers delivery from the shipper's warehouse to receiver's warehouse. This rate has been averaged and is believed to be a fair one to use in comparison with the [illegible].

[illegible] LESS CARLOAD [illegible] MOTOR TRUCK [illegible] PER 100 LB.

[illegible]	Via freight.	Via motor truck.	Miles by road.
[illegible]	[illegible]	[illegible]20	26
[illegible]			
[illegible]	[illegible]	15	12
[illegible]	[illegible]	18	18
[illegible]	[illegible]	20	22
[illegible]	[illegible]	[illegible]	18
[illegible]	[illegible]	40	36
[illegible]	[illegible]	60	63
[illegible]	[illegible]	80	101
[illegible]	[illegible]	1.00	116
[illegible]	[illegible]	1.20	124
[illegible]	[illegible]	[illegible]	142
[illegible]	[illegible]	63	27
[illegible]	[illegible]	[illegible]	30
[illegible]	[illegible]	65	35
[illegible]	[illegible]	68	44
[illegible]	[illegible]	70	58
[illegible]	[illegible]	[illegible]	75
[illegible]	[illegible]	[illegible]	72
[illegible]	[illegible]	[illegible]	60
[illegible]	[illegible]	[illegible]	65
[illegible]	[illegible]	[illegible]	86
Waterbury, Conn.	1.16	.75	96
[illegible]	1.16	.75	95
Hartford, Conn.	1.21	.90	113
[illegible]	[illegible]	1.00	140
[illegible]	[illegible]	1.10	200
[illegible]	[illegible]	[illegible]	190
[illegible]	[illegible]	1.50	234
[illegible]	[illegible]	1.10	199

In explanation of his figures, Mr. Bauham points out that in practically every instance it is necessary to prepare material for freight shipment in an entirely different way than if it moved via motor truck direct from the shipper to receiver. It is necessary to go to considerable additional expense by boxing or crating or to protect by other means in order to prevent loss or damage in transit.

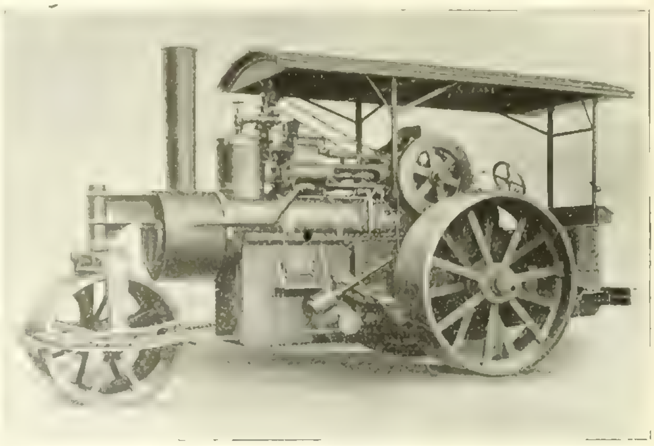
This aditional packing expense is necessary on account of the number of handlings the less-than-carload shipments receive at the hands of the teamsters and carriers after the material leaves the shipping department. This added protection and expense can be greatly reduced if shipments are made via motor truck, and the packages only need protection for loading at the shipper's warehouse in transit without transfer and unloading at receiver's warehouse.

After the goods have been properly prepared for shipment and the necessary shipping documents are made out, delivery must be made to the local freight house either by truck or other means, which increases the transportation cost to the amount of the teaming and additional labor.

A study of the comparative cost of rail and truck transportation as given in the accompanying table, brings out some interesting figures. It shows, for instance, that over the good roads along the eastern seaboard it is 15 ct. per 100 lb. cheaper to ship the Otis company's goods between New York and Boston by trucks, even though the distance is 234 miles. On the short haul work the truck's superiority is manifest; as for example the truck rate to Newark is 15 ct. per 100 lb. as compared with 91 ct. by freight, including packing and teaming charges at both ends. In other words, the truck is about six times cheaper than the rail method from New York to Newark and about four times cheaper than to Elizabeth, N. J.

Roller Specially Designed for Modern Road Work

A steam roller, specially designed for the making and maintenance of modern crushed stone and gravel roads, is illustrated. The special features of the machine are its boiler capacity, transmission bearings, gears and speed range. The boiler heating surface is 119¼ sq. ft. and the grate surface 55½ ft. The boiler has a diameter of 28 in. and has 45 tubes, each 52½ in. long. The transmission is assembled as a single unit and is carried in a cast steel case, which enables all its bearings and gearings to be carefully aligned and assembled before the case is attached to the boiler. Two gear speeds are provided—the sliding change gears are made separately and bolted together, so that either can be renewed without buying both. The crankshaft pinions and countershaft gear can be removed without lifting the shafts they are on from their bearings. The face of the intermediate gear is 2¾ in.; of the main gear it is 3½ in. The machine has a traveling speed on low gear of 1.72 miles per hour; on high gear the traveling speed is 2.72 miles. This roller is built by the Austin Manufacturing Co., Chicago.



Austin Steam Road Roller.

Dividing Maintenance of Motor Vehicles Into Classes

The Chicago Motor Bus Co., operating a fleet of 50 vehicles with a heavy mileage, does not allow its drivers to have anything to do with the maintenance of the vehicles. For the maintenance has worked out a system of three classes of men—mileage, service and maintenance men. This system is described by Mr. Harold B. Weaver, Consultant of the company, in the 100% Magazine, from which we quote as follows:

The principle upon which we are working is maintenance upon a mileage basis. Our vehicles are taken in at the end of 2,000 miles. Whether there is anything needed or not, there are certain things done at that time. They come in again at 4,000 miles, and certain things are done then that were not done at 2,000 miles. At 8,000 miles they have a complete overhauling.

We have established, as far as possible, permanent crews in that work so that if a vehicle is out on the road and develops a defect, that maintenance is charged against service maintenance, the theory being that the vehicle should never have any maintenance other than the two, four, or eight thousand miles.

The advantage of the method is that a definite and easy means has been reached for increasing the points of mileage inspection; manifestly if you can make those points three, six, and twelve thousand, you have automatically cut your maintenance in half. You are apt to go astray if you do not take into consideration in your maintenance, the defects.

Now, under our bonus credit system, the crews are put into competition; for instance, one crew has maintained a certain number of vehicles for 1 ct. per mile on the mileage maintenance basis, and against that, it develops that the vehicles retained by another crew have cost ½ ct. a mile—there is a definite check. The men are then called together for a conference. The figures are explained to them and we take such stps as are necessary to improve the conditions.

But here is the whole thing in a nutshell– the balance of the proposition. We have only had the scheme in operation about six months, and we haven't gone far enough to say that it is perfect—it is approaching the perfect, perhaps, but it is so far proving very beneficial and I think that the idea of the two classes of maintenance, and the separate costs, can be further developed.

Bonding Companies and Road Contractors

Some pertinent information regarding the relation of the surety company and the contractor was given by Mr. Edward W. Bush, Engineer of the Aetna Casualty & Surety Co., in a discussion at the recent convention of the American Road Builders' Association. We quote from the discussion as follows:

It is only by the co-operation of the contractor and the engineer in providing the surety company with full information that the companies can eliminate the irresponsible contractor. Most contracts provide—it is really an understood provision—that the contract will go to the lowest responsible bidder, and very often county officials or state officials will accept the filing of a bond as fixing the responsibility of that low bidder. It is greatly to the interest of the engineers and greatly to the interest of the responsible contractors that they encourage their surety companies to make full investigation of all the circumstances surrounding the letting of a contract, the information regarding the contract, their financial strength and everything that will help them determine whether the contractor can successfully complete the work at the prices named. I would like to say that generally we do get this information, but very often we do not.

I think that sometimes the contractors fail to realize exactly what the surety company is selling for his bonding fee. It sells him credit, just the same as a banker does, and we have an axiom in the bonding business that a contractor should treat his surety company as he does his banker. When an application for a bond is made, the contractor really invites the surety company to become a partner in his business or in his undertaking, and the surety company would like the same kind of information regarding the prospects of coming through with a profit that any other partner would like if invited to invest a certain amount of credit in the undertaking.

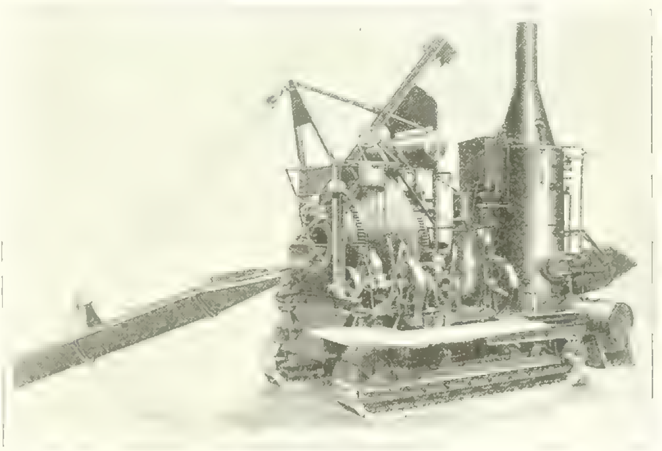
In our company we get applications for road bonds from all over the United States. Somet'mes we get a copy of the contract and specifications filled out in the manner in which they will be executed, but more often we do not. The information submitted to us does not tell which of alternate bids has been accepted. Sometimes you cannot take take the bid prices and compute them out to equal the total amount of the contract. Frequently there is a confusion in terms, as to whether the contract is a lump sum contract or whether it is a contract based on unit prices.

A short time ago I was reviewing a contract in which it was very evident that the local lawyer had prepared the contract and the engineer had prepared the specifications. There was confusion in terms so that if the contractor was delayed in his work beyond the time of completion, the county would pay him a penalty of $25 a day. They had transposed the party of the first party and the party of the second part. I believe the surety companies would very much apreciate it if the engineers would take an interest in seing that proper and exact information is supplied the contractor for the benefit of the surety company. I can appreciate very often the viewpoint of contractors and engineers, because it was only a few years ago when I was in the active construction game myself, both as engineer for the contractor and as engineer in designing and constructing work.

I think that eliminating the guarantee regarding payment for materials and labor would probably make the business more desirable to the surety companies. As a class, road contracts are not as desirable as some other classes. As has been very well shown here in this discussion, they are extremely hazardous.

Paving Mixer with Caterpillar Tread

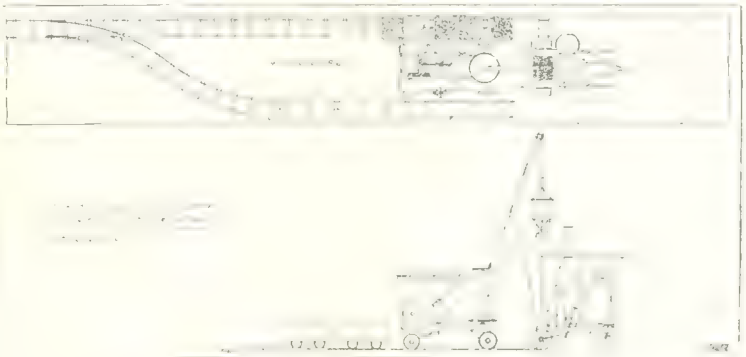
A paving mixer equipped with caterpillar tread that is stated to give a ground pressure less than that of the average walking man is illustrated. Each tread is 9 ft. long and 14 in. wide and is driven independently through a friction clutch. Its construction permits the machine to turn in its own length. The mixer shown is a Foote paver. This mixer is also equipped with a batch meter which can be set for any mixing time desired and which, in addition to fixing the mixing time, locks and unlocks the discharge trough so that until the mixing time previously determined upon has expired, the concrete cannot be discharged from the mixing drum. These improvements are put on both sizes of Foote paving mixers, the No. 16 rated at 11 cu. ft. mixed concrete per batch and the No. 27E rated at 18 cu. ft. of mixed concrete per batch. These machines can be equipped with either a gravity chute distributor, as shown in the illustration, or with a boom and bucket distributor. The machines are manufactured by The Foote Co., Inc., Nunda, N. Y.



Foote Paver with "MultiFoote" Tread.

Auto Crane for Handling Batch Boxes to Mixer

The tendency for the past few years on large cement road contracts has been to eliminate as much as possible the very expensive hand labor element at the mixing end of the job. On many jobs this has been done by centralizing the material at a given point and transporting to the road in batch box trains traveling on industrial track. An auto crane specially designed for handling these batch boxes from industrial car to mixer skip or batch hopper, has been brought out recently by the John F. Byers Machine Co., Ravenna, Ohio. This crane is equipped with two friction drums, forward and reverse propelling mechanism, boom swinger and bull wheel. It is operated by a 10 hp gas engine. The crane has a capacity of 2 tons at 10 ft. radius, and its width is such that it can operate

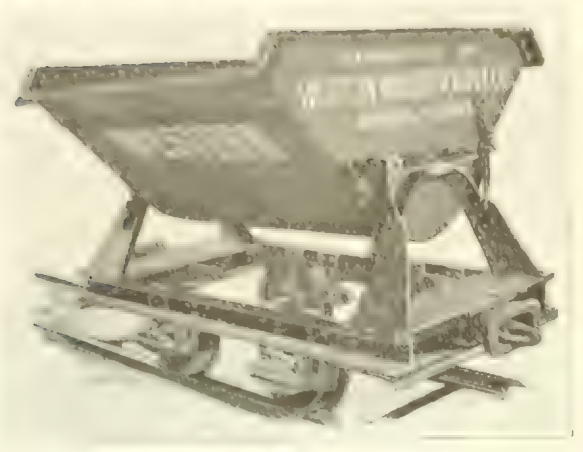


Arrangement for Charging Batch Hopper of Mixer.

[illegible] track and [illegible]

1 1-2 Cu. Yd. Dump Car for Road Work

[illegible] designed to meet [illegible] the West [illegible] The car has roller [illegible] body is arranged to [illegible] The end frame con-



Western Road Builders Dump Car.

[illegible] This company also is manufacturing a truck for carrying mixer charging boxes for concrete road construction. The truck is 24 in. gage and has a capacity of 20 tons. These trucks are the same as are those [illegible] and may be changed into dump cars by attaching the arched body supports and the bodies.

Provisions for Safety at Grade Crossings

Even the casual observer has had brought to his attention the fact that the conditions relating to safety at railroad grade crossings have undergone a marked change within the last few years. Trains have increased in number, speed and length; additional tracks have been laid, thus increasing by so much the chances for danger; many a highway which but a few years ago carried nothing but slow moving horse-drawn traffic has today a preponderance of swiftly-moving motor traffic, including some heavy trucks with speeds of 10 to 15 miles per hour. The improvement of highways has meant not only increased amount of traffic, but greatly increased speed. This is to be expected, but as in many other things, increased privileges have brought increased responsibilities or liabilities to danger in this case.

Track elevation inside city limits and occasional separation of grades in country districts where the topography is favorable have automatically eliminated the danger at these points and enabled both railroad and highway traffic to maintain speed, but there are thousands of grade crossings on improved highways (and others which will soon be improved) where protection to the public is demanded and where it devolves upon the railroad engineers and the public officials to work together toward this end.

Forms of signals which served well enough for horse-drawn traffic seem wholly inadequate for the swifter moving motor traffic. The motorist unfamiliar with the road needs to be advised of the necessity of a stop in time to give him plenty of time to reduce speed before actually reaching the danger point. This means, in many cases, that the signals and warnings must be at a considerable distance from the track, and therefore usually outside the railroad right of way, and this in turn means that the railroad has been without the right to put up the signals or the authority to maintain and protect them from injury.

A committee of the American Railway Engineering Association has found upon investigation that this problem has been solved in eight states by placing the responsibility for the cautionary signals on the state, county or municipal authorities. These states in order are New Hampshire, Vermont, Massachusetts, Connecticut, Maine, California, Oklahoma and Illinois. Bills providing for similar laws are pending in the legislatures of several other states.

The report of the National Association of Railroad and Utility Commissioners shows that the design of signs used in New Hampshire and Vermont is not similar to that later adopted by the Association. In Connecticut the cautionary signs must be furnished by the railroads, but installed by the state, county or city authorities. In California the law requires vehicles approaching grade crossings of railroads to run at a speed not exceeding 15 miles per hour. Tennessee has a law requiring automobilists to come to a stop before crossing railroad tracks. Texas laws require them to reduce speed to 6 miles per hour at all crossings except those protected by gates or flagmen. The state of Washington has a law requiring automobiles carrying passengers to stop before crossing railroad tracks.

The order of the Public Utilities Commission of Illinois, issued July 31, 1918, in the execution of statutes passed by the state legislature in June, 1917, prohibits the installation of any other signs or signals, such as advertising notices, within 300 ft. of any railroad grade crossing, to prevent any possibility of confusion with the regular crossing protection signs. This is an excellent provision, but does not go far enough. Rigid restrictions should be placed on the erection of unnecessary signs anywhere on the public highways. The motorist's attention is too often jaded by signs containing misleading inscriptions, and until such notices and signs of fantastic design are prohibited, there will, of necessity, be more or less confusion with actual warning signs.

The Commission's order included explicit specifications and drawings for both the "stop" and "approach" signs. They must be made of No. 16 gage porcelain-enameled metal, crimped backward at least ½ in. around the perimeter. The letters must be black on a white field and the rear of the sign is painted black. The supporting post may be either wood or iron, but must be of sufficient strength to make a solid and substantial support. The posts must be designed to permit a bracket or attachment to be installed for the purpose of supporting a light or signal at night, wherever, in the opinion of the Commission, this may be necessary.

The painting of black and white diagonal stripes on crossing gates and the use of circular disks instead of flags by crossing watchmen have now become common on many railroads.

We are sanguine enough to believe that at no distant date the practice in the different states will become standardized so that the protection of the public at railroad crossings will be the same, whether in Maine or California, in Minnesota or Texas

Industrial Notes

The Chicago Pneumatic Tool Co. announces the election of Allan E. Goodhue as managing director of its English subsidiary, the Consolidated Pneumatic Tool Co., Ltd., whose offices are at 170 Piccadilly, London, and whose plant is in Fraserburg, Scotland. Mr. Goodhue will also be in charge of European sales for the Chicago Pneumatic Tool Co.

The Blaw-Knox Co. announces the appointment of J. E. Mason as manager of field sales, in which capacity he will supervise the operation of a wide sales agency plan throughout the country. Mr. Mason for the past four years has been connected with the McGraw-Hill Publishing Co., New York City, and since July, 1917, was in charge of the Chicago office of the Engineering News-Record.

Trade Publications

To promote the good roads movement all over our country and to impress upon our citizens the military necessity of improved highways is the object of a booklet, "Highways and Railways for the Defense of Our Nation," issued a few days ago by Sauerman Bros., Monadnock Block, Chicago, Ill. The booklet contains a carefully worked out general plan of defense that calls for the construction and improvement of many miles of highways and railways. The plan was prepared by Capt. H. B. Sauerman in October, 1916, and was probably the first to suggest the construction of a line of highways belting the entire coast line and the southern border of the country. The booklet is illustrated by numerous photographs, maps and drawings showing fortified positions, trenches and other details that form a part of the defense plan.

The Koehring Machine Co., Milwaukee, Wis., has issued a book giving in blue print form the investigations of its engineers into all the various methods of handling highway work of all characters, embracing haulage, central loading stations, mixer equipment, water supply, distribution of materials on the subgrade, etc. Each blue print is 36 inches long and contains useful suggestions for contractors and engineers. For instance, one blue print and table of figures shows how to distribute materials on the subgrade in piles 15 feet apart for use with a mixer loader, according to capacity of mixer and proportions of mix.

The Lakewood Engineering Co., Cleveland, O., has issued a new bulletin describing its road construction equipment. The first half of the bulletin is devoted to a description of the method employed to manufacture roads in large quantities. The balance is devoted to descriptions of the equipment used.

Waterworks and Hydraulics Monthly Issue

ENGINEERING AND CONTRACTING

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Cleveland Office: Room 413 Engineers' Bldg., LEO EHLBERT, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C.(52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The *articles* in the first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering and contracting field. The *articles* in the first and last issues of each month (1st and 4th Wednesdays) completely cover county engineering and highway engineering and contracting. The *articles* in the third and last issues of each month (3rd and 4th Wednesdays) completely cover steam and electric railway location, design and construction. See the "mast head" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
- (a) Roads
- (b) Streets
- (c) Street Cleaning
- (d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
- (a) Waterworks
- (b) Sewers and Sanitation
- (c) Irrigation and Drainage
- (d) Power and Pumping
- (e) Management and Office System

Railways and Excavation—3rd Wednesday
- (a) Excavation and Dredging
- (b) Rivers and Canals
- (c) Quarries and Pits
- (d) Railways, Steam and Electric
- (e) Management and Office System

Buildings and Structures—4th Wednesday
- (a) Buildings
- (b) Bridges
- (c) Harbor Structures
- (d) Miscellaneous Structures
- (e) Properties of Materials

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Volume LI. CHICAGO, ILL., MAY 14, 1919. Number 20.

"How Can I Sell My Expert Services to Small Cities?"

The average expert in the civil engineering field is usually discouraged over the difficulty of selling his services to smaller municipalities. His advice is badly needed, yet he finds neither recognition of that fact nor any indication that public enlightenment is likely to be much greater in the near future.

Our advice to such experts—be they hydraulic engineers, scientific managers, or what not—is to "go gunning after jobs." Cast aside the forlorn hope that your merits will some day bring patrons to you. Make up your mind that it is your duty to sell your experience and ability. You need fear no loss of professional reputation from soliciting work from mayors and aldermen. They have seldom heard of codes of professional ethics; and, even if they have, they rarely think of an engineer or manager as belonging to classes that must hang out "shingles" and wait for clients. In fact, the modern engineer is fast coming to see that it has been a mistake to emphasize the professional side of his occupation at the expense of the business side.

There are thousands of small cities and towns that are constantly in need of expert advice which they struggle along without. It may be that an experienced filtration superintendent is needed, but the town is too small to afford to pay for the entire time of such a man. Must the town, therefore, do without one? No. Let it join with some other town or towns in hiring the expert. This is what the water companies of Ashtabula and Conneaut recently did.

The health department of Ohio says that half the privately owned and one'quarter of the municipally owned filter plants in that state are not under expert control. We cite this merely as an example of the opportunities that exist. In a way, it is a rather poor example for our purpose, because a much worse condition as to economic than as to sanitary management exists everywhere.

There are countless latent opportunities for civil engineers, but most engineers balk at attempting to persuade people to employ them. The average engineer will bemoan the fact that an incompetent politician holds the job of superintendent of streets or of waterworks, yet he will not raise a finger to persuade the public that a change should be made. He will "sit" by while the municipal utilities are grossly mishandled by operators selected because of their political influence. He will see thousands of dollars wasted annually by an ignorant superintendent, and not once make a move to bring the waste of public funds to an end.

Must false ideals and professional modesty continue to operate to the disadvantage both of engineers and of the public? We trust not.

28 Pages = 40 pages

The 28 pages of articles in Engineering and Contracting contain as many words as 40 pages of the size and typography commonly used by other engineering periodicals. Ours is the same size of type and type-page as that of The Literary Digest—easily read, yet giving a large volume of reading matter per page. Our 28 pages of articles would fill 112 pages of the standard 6x9 in. text-book. It would take 10 such books of 580 pages each to hold all the articles printed each year in Engineering and Contracting, to say nothing of our weekly construction news.

Let the Founder Societies Become Post Graduate Schools of Engineering

[illegible] The [illegible] the knowledge of its members [illegible] meetings of the society [illegible] followed. Later [illegible] report on [illegible] great majority of the [illegible] listened at all. In [illegible] somewhat after the pattern of a technical school, except that the teachers [illegible] were not obliged [illegible]

[illegible] their transactions [illegible] lectures and more like magazine articles, until today the national engineering society is little more than a group of subscribers for an engineering journal that is edited by a few of its members. If this line of development continues, it is evident that national engineering societies will become mere competitors of engineering magazines. Already this is nearly true of one of the four "founder societies," the Society of Mechanical Engineers.

At a time when all the old national engineering societies seemed destined to become little more than subscribers for their own magazines, three things happened almost simultaneously. First came the local chapters of the national societies. Second came the doctrine that engineering societies should take a part in public affairs and should also become the guardians of the financial welfare of their members. Third came a new national society that proposed to specialize in performing the two functions just named.

We are in the midst of a professional ferment consequent upon these changes, and it is not easy to foresee the outcome. However, it is well known that evolution tends toward the specialization of an organ for each function. This is true not only of organic but of social evolution. We may therefore predict, with considerable certainty, that the "four founder societies" will not continue to exercise all the functions that they are now exercising or planning to exercise. One society can not be equally successful in conducting: (1) A postgraduate technical school, (2) an engineering magazine, (3) a social club, (4) a union to protect the financial affairs of its members, (5) a bureau to educate the public about engineering matters.

If any national engineering society undertakes to perform all these functions, can it survive against the competition that will certainly be encountered? Already a battle for supremacy is on between the Journal of the American Society of Mechanical Engineers and the various mechanical periodicals. The "Journal" has become, in form as well as in contents, a direct competitor of several powerful periodicals. It carries a considerable amount of advertising, and in other ways is progressively reaching into the field of commercial journalism. Will it win in this competitive struggle? We doubt it. But even if it were to become supreme as a commercial journal, would it not do so at the expense of some other function of the society that publishes it? We think so.

The "four founder societies," through their Engineering Council, are beginning to compete with the American Association of Engineers in the performance of another function—the protection of the business interest of engineers. Whether the Engineering Council will prove as effective as the American Association of Engineers is open to question. If we may judge by their respective efforts during the last year, the American Association seems most likely to perform this function better than the Engineering Council. But here again the primary question is not so much which organization can perform a given function best, but whether any one organization can perform several distinct functions sufficiently well to compete successfully with other organizations that specialize.

Engineers' clubs came into existence because engineering societies failed to function well as social organizations. We look to see the continued growth of old engineers' clubs and the organization of new clubs, for it is not probable that any other form of organization will meet the social needs of engineers. In like manner, and for a like reason, it seems probable that a special society will be needed for the most effective protection of the financial interests of engineers and the education of the public to a recognition of the worth of engineering.

If we are right it follows that the "four founder societies" will have but two major functions to perform, and probably it will not be long before they will have to choose definitely between those two, namely, conducting a postgraduate school or running a newspaper.

As editors, we are perhaps somewhat biased against the attempt of any engineering society to compete with an engineering paper; but since the American Society of Civil Engineers is making no such attempt, we are not biased by any existing competition in our own field of engineering.

The "four founder societies" exercised only one important function for many years. It was an educational function, and the lecture method was the typical way employed to teach the members. At first the instruction was entirely oral. Later it became the practice to print the lectures, and they were then called "papers." The discussion of these papers often were quite long lectures themselves. This method of postgraduate teaching was admirable as far as it went. Its main defect arose from failure to imitate undergraduate methods of teaching. Every member of the society should have been required to study some topic and report the results of his search and research. In short, the Chautauqua method, or something analogous to it, should have been developed by the "four founder societies," and made effective through local chapters. Thus and thus only was it practicable to accomplish the original and primary object of these societies in a thoroughly effective way. The primary object was to educate the members, and the object has not been well accomplished. The pitifully small use made of the library of the founder societies is alone sufficient evidence that the average member is a poor student. Count the number of members that discuss any paper, and contrast that number with the total membership of the society, or even with the number of specialists who should be interested in the paper. You will conclude either that relatively few have read the paper, or that almost none had any facts to add to it. Either of those inferences serves to condemn the system under which the members are presumed to be augmenting their technical knowledge.

The plain fact is that most engineers do not continue to study engineering systematically after graduation. Their college courses have failed to fix in them the habit of continually searching for knowledge. The lecture or paper method of instruction used by engineering societies also has failed to develop the habit of searching for knowledge. We can conceive no more important duty of an engineering society than to train its members to become systematic seekers and disseminators of knowledge. To perform this function well presents problems enough to arouse the ambitions and hold the entire attention of the ablest secretary and board of directors of the greatest of engineering societies. If this one function has never been well performed by the founder societies—and we submit that it has not—why seek to add several more functions?

How Should the Cost of Water-Main Extension Be Met?

One of our contemporaries recently said, "How best to meet the cost of extending water mains is not so easy a question to answer as may appear at first thought. . . . The easiest way is to adopt the pro rata frontage basis. Is it the fairest and best way? If the property owners voluntarily and unanimously agree to such a plan, perhaps no one need complain, but if the city must use compulsion on some property owners then the question arises, Is the plan equitable? The subject bristles with questions."

Since a waterworks is a revenue producing plant, it is manifestly unfair to assess the cost of water mains upon abutting property. Not only is it unfair but it acts to retard the extension of the system. Owners of undeveloped lots are likely to oppose water main extensions in front of their land, unless they are about to build. This is bad enough, but, to make it worse, there is the difficult problem of satisfactorily prorating the cost.

As an alternative, users of an extension are often required to pay enough annually to yield a specified rate of interest on the cost of their extension. This frequently puts an excessive burden upon a few consumers, causing them to pay several times as much for water as the average consumer pays.

The most rational solution of the problem is based upon a clear recognition of the fact that it usually costs money to develop the business of a new plant or of a new extension to an old plant of this nature. This "development cost" is the deficit in interest earned on the new extension during the period when the land is being settled by new residents. The net earnings of the plant as a whole should be sufficient to pay interest on the entire investment, inclusive of the investment in extensions and additions. Bonds should ordinarily be issued to build extensions. In a given city water rates should be uniform for equal service, regardless of where a consumer is located.

Adequate waterworks development seldom occurs where it is attempted to make pioneer consumers pay the entire development cost—that is, the entire interest on extensions. Steam railways, trolley roads, telephone and electric light systems have all been developed on the theory that the residents in new districts should pay only the average rates for service. No municipality should depart from the time-tested methods of private companies, unless experience discloses better methods. Yet many a city has abandoned company methods of financing water main extensions without any scientific reason for doing so.

Who Should Pay the Operating Expense of City Fire Departments?

Making John pay for what George gets may have justification where society at large is the gainer, but seldom is it justifiable otherwise. If this principle were used as a guide there would be many changes in taxation. For example, the fire department of a city is supported by general taxation, yet its service is quite special and but incidentally general. A fire department is really an insurance department; and, if equity were considered, it should be paid for as an insurance policy is paid for, directly by the policy holders.

Every owner of combustible property in a city should contribute to the support of the fire department, in proportion to the degree of risk and the value of his property. If this were done it would cease to be profitable to own "fire trap buildings" or stocks of goods unprotected by sprinkler systems. So long as fire departments are maintained at general expense, there will be insufficient incentive to build better buildings and install fire protection devices.

During the past 35 years the fire losses in this country have totaled $6,000,000,000—a substantial tax on all combustible property. Statistics are not available to show what the operation and maintenance of all our fire departments have aggregated during the same period, but the cost has been stupendous.

If the public were better informed on economic matters, it might be persuaded not merely to make owners pay directly the cost of protecting their property from fire, but to turn over the fire departments to the fire insurance companies. That such companies would operate fire departments more effectively and at less expense than they are now operated, goes without saying. But the public is readily deceived by the glamour of phrases—"public ownership," "private gain," and the like—so there is little hope that city fire departments will be taken out of the hands of politicians and put into the hands of fire insurance companies. However, it may not be vain to suggest that insurance company methods and rates be used by cities in taxing property for the support of fire departments.

Why Dual Water Systems Are of Limited Applicability

Will most cities eventually sell two kinds of water—raw and treated? Not a few hydraulic engineers answer this question affirmatively. One engineer, for example, recently said:

"Vast sums of money are expended to make water potable, and then it is applied to the extinguishment of fires, flushing sewers and various like purposes, altogether a different use than that for which it was rendered suitable at a considerable cost. This is certainly not in the line of efficiency or economy.

"A consideration of these facts must convince anyone of the prudence, economy and wisdom of conserving the good water for the purpose which nature intended it, and supply for manufacturing and fire service purposes a water which can be obtained at much less cost. In other words, another system of waterworks should be built and separate pipes laid to convey water for many of the uses for which purified water is now consumed."

It seems to us that a question of this sort can not be answered conclusively in such a manner. Whether a single or a dual system will be more economic can be determined only after calculating the respective annual costs of each system. It is quite evident to anyone acquainted with waterworks cost data that the relatively low cost of treating water will prevent any such general adoption of dual water supply systems as is suggested in the quotation above given.

As a rule, filtered water costs only 10 per cent more than raw water, when all elements of cost are included, namely, interest, depreciation and operating expenses. Adding a second water supply system would almost double the investment in plant. Hence the fixed charges (interest and depreciation) on the added plant would alone nearly equal the cost of filtering all the water.

While the foregoing relates to a dual system covering an entire city, a very different answer may result where the secondary or raw water supply is confined to the business and manufacturing districts of a city that uses filtered water. In such cases a secondary system may often be economic.

The Coming Convention of the American Waterworks Association

The program for the 39th annual convention of the American Waterworks Association, to be held June 9-13 at Buffalo, N. Y., has been announced. The first day will be given up to registration and to committee meetings. In the evening the Waterworks Manufacturers' Association will hold a reception and dance at Iroquois Hotel for members and their guests.

The convention will be opened at 9 a. m., June 10, in the assembly hall at the Iroquois Hotel, with an address of welcome by A. W. Kreinheder, Commissioner of Buffalo Board of Public Works. Following this John E. Teeple and John A. Kienle will read a paper on the Relation of the Chemical Industry of Niagara Falls to the Waterworks. Then will come a Round Table meeting for the discussion of problems relating to operation and maintenance of waterworks. Among the topics to be discussed will be: Damage to Fire Hydrants by Motor Vehicles and Remedies Therefor.

At the afternoon session the final report of the Private Fire Protection Service Committee will be submitted by Mr. Nicholas S. Hill, Jr., chairman of the committee. The Question Box will be opened after the committee report is disposed of. At the evening session the following named papers on the Buffalo Water Supply will be presented, illustrated by lantern slides: Buffalo Water Supply with Special Reference to the Filtration Problem; Reduction of Water Consumption by Means of Survey and Constant Inspection. Also a paper by Mr. D. A. Decrow, The Uniflow Pumping Engine.

At the forenoon session on Wednesday a series of papers will be presented by U. S. Government officials and manufacturers on The Trend of Prices. The general business includes: President's address, reports of treasurer, secretary and committees.

At the afternoon session the following papers will be read: Purification of Water for the Army and Field Purification Plans, by William J. Orchard; Air Lift and Water Purification, by John Oliphant.

At the morning session on Thursday Leonard Metcalf will read a paper on the Effect of the War Period, 1914-1918, and Public Control Upon Waterworks of the United States.

Friday will be given up to informal talks on personal war experiences by members of the Association, and unfinished business.

Prices Yesterday, Today and Tomorrow*

By O. P. AUSTIN

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[illegible] attempt to look into the [illegible] the probability as to the [illegible] great and continuous [illegible] painfully conscious, [illegible] of hostilities we [illegible] which some had fondly hoped would come with the close of the war. In a [illegible] reductions but in others there are still advances, and the index figures on foodstuffs in New York today are actually higher than those on Nov. 5, when the whole world so joyously welcomed the apparent termination of the great conflict which had raged for 51 months.

In attempting to determine what is likely to happen in the future we must try to find the cause of the things which have happened in the past, and also to see whether this cause is or is not likely to continue in the near future. When prices began to advance in the opening of the war, we could readily see that the upward movement was due to the urgent demand for the food and raw material required by the enormous armies which had been put into the field, and this cause has been designated the "scarcity demand"; but when we found the advance extending to many articles in which there was no scarcity and which were not used by the armies or utilized in the manufacture of their requirements, we began to realize that a part of the advance must be due to some cause other than mere war or scarcity demands.

Edgar Crammond, the distinguished British statistician and economist, in an address before the London Institute of Bankers on March 26, 1919, stated that the three facts which would tend to make the fall in prices a very gradual one are: (1) the vast increase in the amount of paper money; (2) the huge increase in the amounts of public debts of the belligerents; (3) the determination of labor to maintain wages and improve the standard of living.

World-wide Price Advances.—Raw silk, for example, for which the war made no special demand and which was produced on the side of the globe opposite that in which the hostilities were occurring advanced from $3 per pound in the country of production in 1913 to $4.50 per pound in 1917, and over $6 per pound in the closing months of the war. Manila hemp, also produced on the opposite side of the globe and not a war requirement, advanced in the country of production from $180 per ton in 1915 to $437 per ton in 1918. Mechanically ground wood pulp, not a war requirement, advanced as our publishers are aware, from $14 per ton in the opening months of the war to $35 per ton in the opening months of 1916, and the grade known as "chemical bleached" advanced from $50 per ton at the beginning of the war to $160 per ton in January, 1919. Goatskins, from China, India, Mexico and South America advanced from 25 ct. per pound in 1914 to over 50 ct. per pound in 1918 and yet goatskins were in no sense a special requirement of the war.

Pig tin, produced by Chinese labor in the Malayan Peninsula and the Dutch East Indies and not to a very great extent a war requirement sold in the country of production in 1914 at 30 ct. per pound and in the same markets at 75 ct. per pound in the closing weeks of the war. Sisal grass produced in Yucatan advanced from $100 per ton in 1914 at the place of production to nearly $400 per ton in 1918, and Egyptian cotton, a high-priced product and thus not used for war purposes, jumped from 14 ct. per pound in Egypt in 1914 to 35 ct. per pound in 1918. Even the product of the diamond mines of South Africa advanced from 60 to 100 per cent in price per carat when compared with prices existing in the opening months of the war.

The prices which I have quoted to you are in all cases those in the markets of the country in which the articles were produced and in most cases at points on the globe far distant from that in which the war was being waged. They are the product of countries having a plentiful supply of cheap labor and upon which there has been no demand for men for service in the war. The advance in the prices quoted is in no sense due to the high cost of ocean transportation since they are those demanded and obtained in the markets of the country of production.

Underlying Cause of Advance in Prices.—Why is it that the product of the labor of women and children who care for silk worms in China and Japan, of the Filipino laborer who produces the manila hemp, the Egyptian fellah who grows the high-grade cotton, the native workman in the diamond mines of South Africa, the Mexican peon in the sisal field of Yucatan, the Chinese coolie in the tin mines of Malaya, or the goat-herd on the plains of China, India, Mexico or South America has doubled in price during the war period? The articles enumerated were in no case for use in the war and the prices are those in the country of production and thus not due to the increase in ocean freights or dangers of oversea transportation. The advance has been general, worldwide. In a few articles in which an over-production was occurring in which the demand fell below normal the advance was not so strongly marked but there is scarcely an article in the long list of those entering world markets in which there has not been an advance, no matter how distant its place of production from that in which the war was occurring or how little the war's demands for it or for the labor by which it was produced.

Surely there must have been some general underlying causes for this world advance, this simultaneous demand by people of all classes and in all parts of the globe for higher prices for their products irrespective of their relation to war requirements. While we may be willing to accept the immediate demands of the war as a partial explanation of the advance in the prices of foodstuffs and certain manufacturing material and manufactures we must look farther for the cause of the similar advance in articles upon which the demands of the war could have had no direct bearing. It is true that a marked advance in the price of one important class of products does cause an advance in the prices demanded for other articles which must be exchanged for those in which the advance has already occurred, but it does not seem probable that the advance due to scarcity of a comparatively few of the world products required for war could have been the chief cause of the doubling of prices in practically every article produced in every part of the world, many of which had not the most remote relation to war requirements.

Apparently the principal causes of the advance in prices during the war were, stated in their chronological order, first, "scarcity demand"; second, the advance in wages presumably due to the increased cost of living and demand for labor and, third, the large increase in world circulating media, or to put it in a single word, "inflation." Prof. A. C. Miller, member of the Federal Reserve Board an authority whose views are entitled to high consideration, in a recent address before the American Academy of Political and Social Science named as the two chief causes of the advance in prices, "scarcity demand" and "inflation," adding that "there is so much evidence of an artificial abundance of money in comparison with the things that are purchasable by it that the abundance of money must be credited with at least an equal influence in explaining the high prices which have prevailed."

Scarcity Demand.—What were the articles for which the war created a scarcity demand? Food, clothing, transportation facilities, and material for the battlefield. How much did it add to the world's demand for these articles? Of course, the percentage of increase in demand for strictly war materials was very large, but was there really as great an increase in demand for other materials, food, clothing and trnsportation facilities as we are accustomed to imagine? Let us assume that the number of people participating in the war was 40,000,000, which is probably more than those in the field at any one time. Do we realize how small a share those 40,000,000 were of the world's consuming population? Less than 2½ per cent. We think of 40,000,000 as a large number of people to feed and so it is, but it must be remembered that the number of people in the world who must be fed and clothed and supplied with transportation facilities every day of the year is 1,800,000,000 or 45 times as many as the highest number in the military service at any time during the war.

Of course the soldiers were better fed than are many of the people in certain sections of the world, but even if their per capita consumption was four times as much as the average it would still represent but a small percentage of the world's daily food consumption. And it must be further remembered that all these 40,000,000 people in the armies had been consumers of food before the beginning of the war, not to quite as great an extent perhaps as after entering the activities of the military service, but it cannot be assumed that the war added 40,000,000 to the world's consumers of food and clothing. Nor can it be properly assumed that the withdrawal of these millions from the industries actually reduced to that extent the world's producing power, for 4,000,000 of these were already in the military service and the places of the other 36,000,000 were to a considerable degree filled by others who had not been up to that time actively engaged as producers.

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*[illegible] Conference of the Business Publishers' Association.

Much of the material used in preparing the supplies for the battlefield was "switched" from the usual lines of industry, for there was an immediate cessation of railway construction, building operation, and a thousand industries which formerly required manufacturing material and as a result of this cessation of activities the material formerly used by them became available for war purposes.

It thus appears on close analysis that the "scarcity demand" created by the war was not as great in food, clothing, or manufacturing materials as has been pictured, while the fact that 15,000,000 are still under arms minimizes the reduction in military demands which had been expected.

Advance in Wages.—One factor often mentioned in the attempt to determine the causes of high prices is the advance in wages of labor, but the fact that the increase in compensation of labor was in most cases given because of the fact that the cost of living had already advanced at least somewhat minimizes the relative importance of this factor in attempting to discover the real causes of the general world-wide advance in prices. And it must also be remembered that several million persons who had not been engaged in the industrial and business world came to the assistance of those engaged in these duties during the war.

Money and Credit Inflation.—Where, then, shall we turn in the search for the principal cause of the general advance in prices of articles produced the world over and their relation to the demands of the war? What other cause can we find after giving due consideration to the scarcity demand, the destruction by war and the increased cost of labor? The most prominent among the possible or probable causes is the theory advanced or accepted by the historians, economists, statisticians and financiers of the world that inflation in currency is usually accompanied or closely followed by an advance in prices; and, as already indicated, so high an authority as a member of the present Federal Reserve Board, Prof. A. C. Miller, has recently declared that "the abundance of money must be credited with at least an equal influence in explaining the high prices which have prevailed."

I wonder if we do fully realize the quantity of paper money which the responsible governments of the world have put afloat since the beginning of the war—36 billion dollars. The paper money in existence in the 15 principal countries of the world at the beginning of the war was less than 8 billion dollars and at the end of the war was over 44 billions, an increase of 36 billions in 51 months, and this does not include any of the 80 billion dollars' worth of paper currency issued by the Bolsheviki in the eighteen months of their control in Russia. Thirty-six billion dollars of new paper money added to the circulation of the world by 15 responsible governments in a little over 4 years of time.

We had been inclined to charge up the advance in prices occurring prior to the war to the fact that 8 billion dollars' worth of gold was turned out by the mines of the world in the 20 years following our famous gold and silver campaign of 1896. But here are 36 billion dollars' worth of paper promises to pay turned out as legal tender money by 15 responsible governments in a short four-year period.

Do we realize how vast a sum is this 36 billion dollars' worth of paper currency which has thus been put into circulation in such a brief time? It is more, in its face value, than all the gold and all the silver turned out by all the mines of all the world in the 427 years since the discovery of America. True, much of this paper money is now more or less depreciated in its value as compared with gold, the world's accepted standard, but the fact that it has behind it not only a certain amount of the yellow metal but also the pledge of the governments by whose authority it was issued renders it at least an accepted medium of exchange in the countries of its origin, while the fact that nearly every neutral country of the world has meantime increased its paper currency and national indebtedness, permitting its gold to pass from circulation into the vaults of its banks as a security for the paper circulation, tends to widen the field affected by this inflated currency.

In addition to these vast sums of legal tender currency turned out by 15 responsible governments of the world, these same governments have at the same time made an even more spectacular advance in their issue of another series of promises to pay, which while not legal tender in the ordinary sense of the term, do form a more slowly moving mass of currency. By this I mean the 180 billion dollars' worth of bonds or other forms of national obligations issued by the governments of the world in the past four years, for national debts of the world have advanced from 40 billion dollars at the beginning of the war to 220 billions at its close. And while these bonds or other governmental promises to pay money at some future date are not legal tender currency in the ordinary sense of the term they do pass current in the financial world and prove a basis upon which money may be readily obtained by their holders, and to this extent are an addition to the world's circulating medium.

Bank Deposits Increased.—Still another increase in circulating media is found in the enormous growth in bank deposits, which of itself increases circulation through the increased use of checks, especially in countries such as the United States where the check forms so large a share of the daily business transactions of the country. Bank deposits in 15 principal countries of the world have grown from 27 billion dollars in 1913 to approximately 75 billions at the present time, the ratio of increase being about the same as that of currency.

These increases, in circulation, indebtedness, and bank deposits, while occurring chiefly in the countries participating in the war have also extended to many other countries, especially in Europe, where the six principal neutrals have during the war period increased their national debts 1 billion dollars, their note circulation over a billion dollars and their bank deposits by about 1 billion.

Thus in a short 4½ year period world paper money has increased 36 billion dollars, world evidences of national indebtedness 180 billion dollars, and world bank deposits nearly 50 billion dollars. Most of this enormous increase has occurred in "uncovered" paper. The gold mines of the world have turned out less than 2 billion dollars' worth of the precious metal during the war period and most of the world's gold, which formed 55 per cent of world circulation at the beginning of the war, has passed into the vaults of the governments or their great banks as a basis for their paper currency, and now bears a relation of but about 20 per cent to the flood of paper money in circulation, and this proportion of gold to paper varies widely when the respective countries are compared.

If the world's historians and financiers and economists and statisticians are right in their general belief that an advance in prices usually accompanies or closely follows inflation in currency, and especially in paper currency, can we be surprised at the world-wide advance in prices which we have witnessed during the past four years in which world currency and bank deposits trebled and national debts quintupled

The Prices of Tomorrow.—We come now to the third and final question, that of prices of tomorrow. May we expect a material reduction in general prices in the near future? And in trying to determine this we must see whether the causes which brought about the advance during the war period are likely to be removed.

The chief causes of the advance seem to have been the "scarcity demand," the higher cost of labor, and the increase in circulating media.

The "scarcity demand" came on the very first day of the war, for most of the countries entering that struggle found that the demand upon them would be far in excess of their supplies either of foodstuffs or military requirements, and as the weeks and months and years progressed this fact was more strongly impressed upon them.

During the closing year of the war the ammunition factories of the various participating countries were able to meet to a great extent the requirements of their own armies but in the matter of foodstuffs the "scarcity demand" still continues with little prospect of abatement at least in the near future. The number of mouths to feed in Europe has not decreased, and that continent, which has not for many [illegible] countries, [illegible]

[illegible] Europe has also been [illegible] the world, the [illegible] people [illegible] In all parts of the world [illegible] United States for [illegible] and [illegible] will evidently [illegible] manufacture for ex[illegible] [illegible] that although [illegible] the other fea[illegible] certain at least in a [illegible] future especially as relates to world requirements of food, manufacturing ma[illegible] thus far do not [illegible]

[illegible] a considerable proportion of the world advance in prices is due to the enormous increase in world currency can we expect a marked reduction in prices until the cause, "inflation," is removed? Or, to put it in another form, that part of the advance caused by in[illegible] by a reduction in the enormous stocks of currency which, as I have shown you, has trebled during the war, while that other form of slowly moving currency, governmental obligations, has quintupled.

Is it probable that these two forms of currency can be or at least will be reduced in the near future? The governments [illegible] paying less than 2 billion dollars a year interest on national debts at the beginning of the war, [illegible] to pay a total of over 10 billion dollars a year in interest, and at the same time all other expenses of governments have advanced. Official estimates of the "budgets" or expense accounts of several of the principal countries for the coming fiscal year have already been announced and indicate that their necessary expenses in the first full year of after-war peace will be about four times as great as in the year preceding the war. The British budget for the next fiscal year is estimated at about six times as much as in 1913 and those of France, United States and Canada about four times as much as before the war. Present indications are that the governments of the world will be compelled to collect in taxes from their people about 50 billion dollars a year as against about 12½ billions in 1913, or say a billion dollars a week as against a billion dollars a month before the war, and this does not include anything for "sinking funds" or other provision for reduction of outstanding debts. If this be true is it probable that the governments in those countries which have greatly increased their circulation and must now demand such enormous increases in annual payment of taxes will find it advisable or possible to reduce materially the amounts of currency available for such payments?

If the governments which have been the chief participants in the world increase of currency should fail to reduce materially that excessive supply, and if the world's demand for food, manufacturing material and manufactures is to continue at the present rate, are we justified in expecting a general reduction in prices in the near future? The question I think answers itself. There will, of course, be instances in which there will be material reductions, but in general terms the outlook for marked or rapid decline, at least in the near future, does not seem encouraging.

Annual Convention of Southwestern Waterworks Association.—The Southwestern Waterworks Association will hold its annual convention at Kansas City, Mo., June 23-26. The headquarters will be the Coates House and the exhibits will be lodged in this hotel. A number of excellent papers will be presented by engineers and waterworks superintendents. A feature of the convention will be five minute talks by engineers and waterworks superintendents on the various problems and perplexities that have come up in their experience. O. G. Smith is secretary of the Association and Jos. W. Ivy, 505 Interstate Bldg., Kansas City, Mo., is chairman publicity committee.

New Outdoor Swimming Pool at Cincinnati Will Accommodate 4,000 Bathers at One Time

One of the largest outdoor swimming pools in the world is to be placed in service this summer at New Krug Park at Cincinnati, O. The pool will have a water surface of more than an acre, while the beach which entirely surrounds the pool will cover another acre. Bath house facilities will be provided for the accommodation of 4,000 persons at one time, or as many as 1[illegible]000 to 20,000 persons during the day and evening.

The pool will be constructed of reinforced concrete with a white enameled surface. It will be dish-shaped except at one end, where provision is made for diving and aquatic sports. A special method of constructing the floor of this pool will eliminate cracks and crevices caused by the expansion and contraction of the concrete, which would otherwise furnish pockets where dirt and filth might accumulate. Around the pool on the shallow sides just enough depth of water is provided for stepping off from a sitting position on the surrounding curb. A cleaning device, similar to the well known vacuum cleaner, with a sweeper 5 ft. long and using a large centrifugal pump, will be used for cleaning the floor.

Swimming Pool at New Krug Park, Cincinnati.

Encircling the pool will be a sand beach over 30 ft. wide and with a depth of over 2 ft. of white beach sand. This will be laid on a concrete foundation, so that the sand may be kept moist and at the proper temperature even on the hottest days.

The water for filling the pool will be taken from the regular city supply, over 1,000,000 gal. being required for this purpose. The water will be kept in circulation through the pool, a complete change being made every 12 hours.

The water before entering the pool will be screened, coagulated, filtered and purified by the ozonization process. In addition, all the water in the pool will be aërated by being constantly pumped and circulated over large cascades.

The purified water will enter the pool continuously at various points around the circumference of the pool, about 50 ft. apart and under the surface of the water, and will be drawn off through the splash gutters entirely surrounding the pool as well as continuously being drawn off from the deepest parts.

Water Consumption at Little Falls, N. Y., in 1918.—The total water consumption at Little Falls, N. Y., for 1918 was 1,287,363,000 gal. The estimated population supplied was 13,500. The daily per capita consumption was 262 gal. and 1,550 gal. per day was supplied to each tap. The cost of supplying water, figured on total maintenance was $14.26 per 1,000,000 gal. The percentage of consumption metered is 35. The per capita consumption increased during the month of February to 301 gal. per day. This was due to the fact that many consumers had to keep their faucets running continuously to keep the services from freezing. The consumption increased again during September to 275 gal. per capita per day. At this time the Venturi meter records showed a week day consumption of 4,257,750 gal. with but 2,565,750 gal. as a minimum Sunday consumption. This variation continuing approximately the same through the months of August and September is a fair indication of the industrial activity of the city at that time.

The Bacteriological Standards for Drinking Water Supplies in Interstate Commerce*

By EVERETT JUDSON,
Assistant Sanitary Engineer, U. S. Public Health Service

Pursuant to the recommendation of the Surgeon General of the Public Health Service, the Treasury Department on Oct. 21, 1914, adopted a bacteriological standard for drinking water for the purpose of administration of the Interstate quarantine regulations as they relate to the drinking water supplied to the public by common carriers in interstate commerce.

The standard was recommended by a commission of leading sanitarians and bacteriologists of wide experience. Their recommendations fixed the maximum limit of permissible bacteriological impurities as follows:

A. The total number of bacteria developing on standard agar plates, incubated 24 hours at 37° C. shall not exceed 100 per c.c.

B. Not more than 1 out of 5/10 c.c. portions of any sample examined shall show the presence of the organisms of the bacilus coli group. This requirement is usually expressed as not more than 2 colon per 100 c.c.

C. The analytical work shall be carried out in accordance with the "Standard Methods of Water Analysis," of the American Public Health Association.

The standards were intended to fix the maximum allowable bacteriological deviation from purity which would be permissible in drinking water supplied to the public by the carriers, and were to be applied to samples taken from the containers. This committee stated clearly in its report that these limits were applicable for this use only. Considering conditions it seemed advisable to allow 100 as the maximum total count. The limits recommended for the colon count were placed at 2 per 100 c.c. as to make them more rigid would have necessitated, on the one hand requiring absolute freedom from bacteria, or on the other hand increasing materially the amount of laboratory work necessary to ascertain compliance with the requirements.

Some sanitarians consider this limit too severe. It is believed, however, that when supplies must be passed upon without a field survey that this maximum is none too rigid. In fact, in working on the water supply of lake boats, it has been found that when only two colon per 100 c.c. were present the supply had been subjected to serious pollution. The apparatus for treatment of the drinking water supply on these boats entirely eliminates colon when properly used. Whittaker of Minnesota reports that of a total of 344 unsatisfactory water supplies, 8 per cent were detected by the laboratory analysis alone, while 40 per cent were detected only by the field survey. They used the Treasury Department standards. Surely, if 40 per cent of the unsatisfactory supplies were not detected by the bacteriological analysis, the standard is not too severe.

It is realized that these standards were the first definite expression of the allowable impurity which a drinking water might possess, and as they were promulgated by the Federal Government, they were immediately seized upon as standards for a wide range of purposes. They became the legal standards locally, and were applied in general to drinking water supplies which were in no way used by the common carriers. To collect and analyze samples from every container on the 80,000 or more cars in use on the railroads of this country was impossible. The only thing left to do was to examine the local supplies from which the containers were filled. It can be readily seen that due to carelessness in filling and icing some which were filled from a safe supply might be polluted. Considerable study has been given to overcoming this difficulty. However, had it been possible to examine the supply in each container, this difficulty would still have existed, making it impossible to rightly judge the local supply from the container analysis. In examining the supply from which the container was filled, we were in many instances examining the city or town supply, and if this did not come within the allowable limits, the carrier was prohibited from taking on this water. Naturally, it would not help the reputation of a city to have its water supply excluded from use on interstate carriers. Usually the supply was made to conform, and the carrier was permitted to resume its use.

Other cities, though, in furnishing interstate carriers did not wish to have a dangerous water while their neighboring city's supply was safe, so they brought themselves up to the standard, and in this manner these standards have become the aim to which the great majority of our cities work, if they are interested in this important measure of sanitation.

The comment is often heard that the limits are so rigid that they place an undue burden upon certain treatment plants. Though the standards were not originally intended to apply to these plants it has been shown by McLaughlin that of 12 representative plants, 7 mechanical filtration, 3 slow sand filtration, and 2 using alum and calcium hypochlorite, 8 are able to meet the standard when the yearly average is considered. He states the belief that a standard of not more than 2 B. Coli per 100 c.c. should be adopted, and expresses the opinion that a modern water purification plant which delivers an effluent having more than 2 B. Coli per 100 c.c. is either inefficiently operated, or is dealing with a raw water which imposes an unreasonable burden upon the plant. If it is inefficient management or a poorly designed plant, we know what to do. If the raw water imposes an unreasonable burden the plant should be made to do its best until relieved. The time will soon come when it will be illegal to allow untreated or insufficiently treated sewage to be discharged into a stream under conditions which will overtax the water purification plant of any city down-stream. Certainly these difficulties which we meet with now should not cause us to lower our standard, when European countries with the low typhoid rates have more rigid bacteriological standards than ours.

As stated above, the laboratory work was to be carried out in accordance with the standard methods of the American Public Health Association. Criticisms of these methods were made by Hesseltine in 1917. He showed that the quantities of sodium sulphite and fuchsin recommended for Endos media are too small, and that the sterilization of the lactose broth in the autoclave for 15 minutes at 15 lb. will invert part of the sugar. Other corrections and additions have been suggested and it would seem advisable to have a new set of standards promulgated in order that pertinent suggestions and corrections may be incorporated. This having been done, the next and most important step is to make a real endeavor to have these standard methods followed throughout the United States. Norton has found that the methods of water examination in connection with 24 purification plants in this country show in no two instances are these methods exactly alike. In some cases the variance is so slight that the results are comparable with slight error, while in others, they are absolutely non-comparable.

It is very natural for the laboratory man who has discovered an easier way for him to do some part of his routine work, to adopt this method; but if this new procedure in any way affects his results, then the use of it makes his work just that much less comparable with the other man's. It is believed that provision should be made for bringing the standard methods up to date whenever new methods have been developed, tried out, and proven on a sufficiently large scale to warrant the break in the chain of results which are kept by many laboratories. Until this change is officially made, the routine work should be done strictly according to the standard. This can only be accomplished by thorough supervision of the work.

Morse and Wolman have gone so far as to contend that we are not ready for "standards of quality" as we have not established the methods of evaluating the units. They suggest a field for future standardization in which they have enumerated 10 points to be covered. It is believed that these points have been covered sufficiently to give us a working basis. Certainly we would not be justified in waiting until we have the last word on any one of these points before we establish "standards of quality." If later research shows these standards should be changed, that can be done, but in the meantime we must have some standard to follow if our results are to be at all comparable.

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*From a paper presented before the Indiana Water Supply Association.

Economical Section of Water Conduit for Power Development

[illegible] with- [illegible] the [illegible] section of a conduit for [illegible] water to a power plant. For this reason a paper [illegible] New York [illegible] meeting of the [illegible] is of particular [illegible]. The paper [illegible] April Journal of the [illegible] taken

[illegible] best slope and size of conduit [illegible] account in a practical manner the construction costs, the value of the power recovered, and the rate of returns expected on expenditures made, [illegible] the other physical conditions of the problem. The [illegible] relation between the best area and the quantity of [illegible] shown in Fig. 2, for chosen values of factors entering [illegible] by a simple modification [illegible] the relation for other costs and unit prices can be easily determined. One interesting result is that for a flume, or for any conduit, for which the increment cost for increasing the capacity by a relatively small [illegible] the best speed of flow [illegible] the water is constant, independent of the size of the conduit.

The economical section is evidently that resulting in the greatest net earnings of the power plant under the conditions controlling the market where the power is delivered. Inasmuch, however, as this section must be determined in advance of complete knowledge of market conditions, it is clear that only an approximation can be made, and that a ready method to determine the variation in net earnings for a large range of sections and shapes of water conduit may be useful.

Assuming that a certain shape and slope of water conduit is fixed upon provisionally, the question is whether some change either in the slope or in the shape or size of the section will result in an increase in net earnings. Any increase in the dimensions of the conduit will obviously entail an increase in construction cost, and hence an increase in annual charges. This increase in annual charges is limited, practically speaking, to interest, amortization and profit, inasmuch as only small changes in a quantity which itself is a small part of the total are under consideration. For instance, under ordinary conditions the loss in the water conduit may vary from, say 5 per cent to 10 per cent of the total power; it is a variation of possibly 25 per cent one way or the other in this 5 per cent or 10 per cent that is involved.

TABLE 1—[illegible] FOR VARIOUS SECTIONS

[illegible]	[illegible]	[illegible]	Section [illegible]	
			[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	2π	2.51
[illegible]	[illegible]	d^2	9	3 00
[illegible]	$d/2$	$2d^2$	[illegible]	2.83
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]				
[illegible]	[illegible]	[illegible]	10.6	3.26
[illegible]	$0.83d$	[illegible]	16 0	[illegible]

It is therefore evident that no increase in operating charges, or maintenance, or repairs need be considered, and that the changes in design of the conduit should carry charges only for interest, amortization, and profit. An allowance for profit on the additional expenditure must be included, since every dollar invested should earn its share of profit as well as its fixed charges.

The increase in power resulting from an increase in the size of the conduit brings in a certain addition to gross earnings. Against this, in theory, should be charged the costs of operation and maintenance on the additional equipment and machinery required to deliver this power to the market; but for the same reasons stated in considering the water conduit, all these charges against the additional gross earnings may be ignored in this analysis, as they are negligible in amount, due to the fact that the increase in the power output is small. There would, in fact, be no increase in operating charges, and under practical conditions there would be no increase in equipment, and therefore no increase in fixed charges on equipment.

The matter then reduces to the comparison of the additional gross earnings from the power recovered by an increase in the size of the conduit on the one hand, and the additional interest, amortization, and profit on the cost of the enlargement of the conduit on the other.

The determination of additional power is simple, involving merely the overall efficiency from the water to point of delivery. A consideration of the value of this increased power is a matter of judgment on the part of the engineers and executives of the enterprise, giving attention to the market conditions under which the power is sold, and particularly to the load factor.

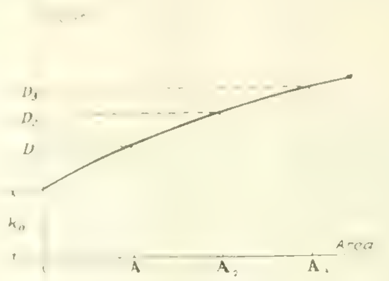

Fig. 1—Relation Between Sectional Area of Conduit and Cost.

The determination of the additional cost of the conduit, however, is more difficult, inasmuch as this cost depends in theory not only on the area of the cross-section of the conduit, but also upon its shape; that is, upon the hydraulic radius of the wetted perimeter. The relation between the area and the wetted perimeter differ, for example, for a rectangular, a circular or a hexagonal conduit, and cannot be expressed in a simple equation to cover all shapes of conduit. The practical way to handle the problem is to fix upon one shape of conduit, determine the economical area and slope for this shape and then follow out a similar procedure for such other shapes as may be practicable in the case under consideration. This determination being made for the several possible shapes, the best result is then selected.

The procedure indicated in the foregoing general discussion can be expressed symbolically as follows:

Let Q = flow in sec-ft., taken as constant.
L = length of conduit, ft.
A = area of conduit, sq. ft.
s = slope of conduit, ft. per ft. of length.
r = hydraulic radius of conduit, ft.
w = wetted perimeter of conduit, ft.
v = speed of flow, ft. per sec.
C = constant in the Chézy formula.
e = efficiency from water to point of delivery × 0.085.

Then the power loss p in the conduit in kilowatts will be

$$p = eQsL \qquad (1)$$

In this equation s is the variable, and any change of p is due to a change of s and is expressed by

$$dp = eQLds \qquad (2)$$

If m is the annual value of one kilowatt under the ruling conditions, then

$$mdp = meQLds \qquad (3)$$

is the added gross (and net) earnings due to the change in s.

As to the cost of increasing the capacity of the conduit, the flow is assumed to be given by the Chézy formula

$$v = \frac{Q}{A} = C(rs)^{0.5} \qquad (4)$$

The best size of conduit is to be determined for a known value of the flow Q; that is, in Equation (4) Q is to be taken as constant. In this case,

and

$$\frac{dQ}{ds} = 0$$

$$\frac{dA}{ds} = -\frac{2A}{5s};\quad \frac{dW}{ds} = -\frac{1w}{5s};\quad \frac{dr}{ds} = -\frac{1r}{5s} \qquad (5)$$

With Q constant, a change in s can be offset by a change in either A or r, or in both; that is, either the size or the shape of the conduit can be varied to keep Q constant.

There is no way of expressing a general relation between A and r, but for any chosen shape, as, for example, a rectangle or semi-circle, the area is proportional to the square of any linear dimension; that is,

$$A = ar^2 = wr = \frac{w^2}{a} \quad \dots\dots\dots\dots (6)$$

The value of a, of course, varies, but for usual forms the differences are not great, and the influence of changes in a on the economical section is slight; in fact, it can be shown that for the best section

$$A \sim a^{1.7}$$

for the conditions of Equation (7a). Table I gives values of a for the usual shapes. For preliminary calculations a = 9 may be used.

The cost of a water conduit can be expressed as a constant, representing the cost of a large part of the preliminary work and plant, plus an amount depending on the size and surface area. In general, the cost per foot may be expressed by

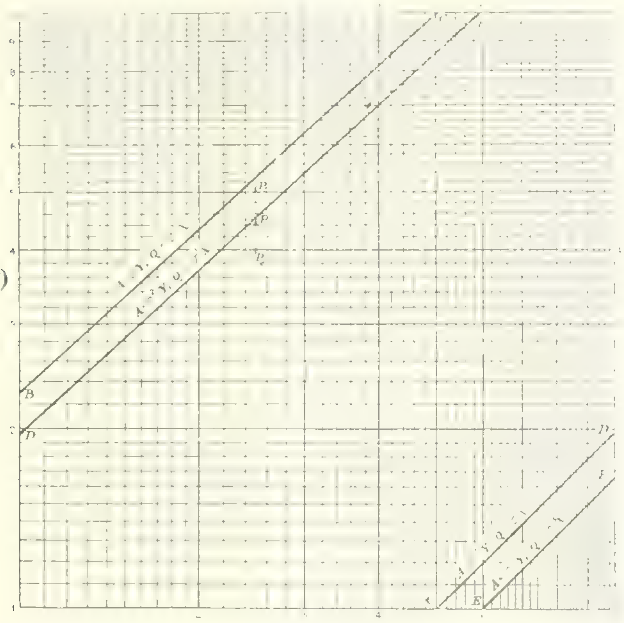

Fig. 2—Logarithmic Graph of Equation 18 for Values of Q From 100 to 10,000 Sec.-Ft.

$$D = k_0 + kA^n \quad \dots\dots\dots\dots (7)$$

where D = cost per foot, dollars
k₀ = constant part of cost per foot
k = a constant
n = an exponent whose value lies between 1 and 0.5.

In any specific case, when all the conditions are known, estimates of the total cost per foot of the conduit should be made for three or more different cross-sections; plotting these values will enable both k and n to be determined.

For example, let Fig. 1 represent the cost per foot for a certain conduit; then k₀ is given at once by the curve, and from

$$\frac{D_2 - k_0}{D_1 - k_0} = \left(\frac{A}{A_1}\right)^n$$

n is determined. Each pair of points should be used and the value of n found. The values of n and k₀ being known, k may be obtained from

$$k = \frac{D_1 - k_0}{A^n}$$

Other methods could be used. The gist of the matter is that the accurate way is to make detailed estimates for several cross-sections and determine the constants from an analysis of these estimates.

Two extreme cases simplify the formula: First, when the increment cost is proportional to the area, as in a heavy rock cut, then

$$D = k_0 + kA \quad \dots\dots\dots\dots (7a)$$

and, second, where the increment cost is proportional to the surface, or the wetted perimeter, as for a flume, then

$$D = k_0 + kA^{0.5} \quad \dots\dots\dots\dots (7b)$$

These are considered later.

If i represents the total rate of returns expected on all expenditures on the property, including interest, amortization and profit, then

$$I = iL(k_0 + kA^n) \quad \dots\dots\dots\dots (8)$$

gives the total returns from this investment, and a change ds in s calls for a change in returns of

$$dI = niLkA^{n-1}\frac{dA}{ds}ds \quad \dots\dots\dots\dots (9)$$

or, from Equation (5),

$$dI = -\frac{2niLkA^n}{5s}ds \quad \dots\dots\dots\dots (10)$$

This saving, due to an increase in s, must be at least equal in value to the power lost, and indeed should exceed it by some margin; this margin can be included in the overall rate of return i, and therefore

$$dI = mdp \quad \dots\dots\dots\dots (11)$$

Substituting in (11) from (10) and (3), there results

$$5meQs = 2kniA^n$$

Substituting further from (6) and (4), namely,

$$s = \frac{v^2}{C^2r} = \frac{v^2}{C^2(A/a)^{0.5}}, \text{ and } Q = Av,$$

gives finally

$$A^{n-0.5} = \frac{2.5mea^{0.5}}{nikC^2}v^3 \quad \dots\dots\dots\dots (12)$$

This may also be written

$$A^{(n+2.5)} = \frac{2.5mea^{0.5}}{nikC^2}Q^3 \quad \dots\dots\dots\dots (13)$$

If

$$N = \frac{2.5mea^{0.5}}{nikC^2} \quad \dots\dots\dots\dots (14)$$

then

$$A^{(n+2.5)} = NQ^3 \quad \dots\dots\dots\dots (15)$$

The best way to handle this equation for engineers is by logarithmic plotting. From (15)

$$\log A = \frac{\log N}{(n+2.5)} + \frac{3}{(n+2.5)}\log Q \quad \dots\dots\dots\dots (16)$$

When n is known, this can be readily plotted for any range of Q desired. As an illustration, assume:

$$m = \$10,\ e = 0.67 \times 0.085 = 0.057$$
$$i = 0.15,\quad C = 120$$

then

$$N = \frac{10^{-3} \times 2}{nk}$$

If, further, n = 0.75 and k = $0.10,

$$n = 10^{-2} \times 2.67$$

and

$$\log A = \frac{\log 10^{-2} \times 2.67}{3.25} + 0.925 \log Q$$
$$= -0.485 + 0.925 \log Q \quad \dots\dots\dots\dots (18)$$

Fig 2 is the logarithmic graph of Equation (18) for values of Q from 100 to 10,000, in four parts; for the line BC the ordinates are to be multiplied by 10 and the abscissae by 100; for CD, by 100 and 100; for DE, by 100 and 1000; for EF by 1000 and 1000—all as indicated by the figure. From this figure, Table II is readily computed.

TABLE II. VALUES COMPUTED FROM FIG. 2

Q	A.	V	r	S (Ft. per 1,000)
100	23	4.35	1.60	[illegible]
500	100	5.00	[illegible]	[illegible]
1,000	191	[illegible]	[illegible]	0.180
2,500	450	[illegible]	16.70	0.128
10,000	1,650	[illegible]	33.30	0.077

Two special cases are of particular interest: First, when n = 0.5 and the increment cost is proportional to the surface; this would approximate the case of a flume or a concrete-lined canal in earth. Here

$$A^3 = NQ^3$$

and, since v = Q/A,

$$v^3 = \frac{1}{N} \quad \dots\dots\dots\dots (19)$$

[illegible] result.

[illegible]

[illegible] (10)

[illegible]

[illegible] (11)

[illegible] may be easily taken [illegible]

[illegible]

[illegible] added to the ordinate of the curve at any point will give the value of N for N = (N [illegible] is to be subtracted. For example, for the point [illegible] N = 150, [illegible] = 5.56

log 1.5   log 1.5

[illegible]

n + 2.5   3.25

[illegible] These values are given in Table III.

TABLE III.

N.	O.	A.	V.
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
$10^8 \times 1.78$	2500	395	6.32

The usefulness of this analysis is limited by the accuracy of the determination of n, and this in turn depends upon the [illegible] costs.

Methods of Cleaning Sand Filters at Brookline, Mass.

[illegible] the Water Department of Brookline, Mass., to determine the best way of operating its filtration plant. This plant was placed in service in 1917 and it became apparent quite early that the best results could not be obtained by operating in exactly the same manner that similar filters were operated. The presence of more or less organic matter and other substances, in addition to the iron and manganese, requires different treatment in each case, and no two waters are alike in these respects. In some instances, if the raw water is aerated too much, more of the iron is liable to slip through the sand, and if sufficient oxygen is not absorbed by aeration, equally unfavorable results will occur. In order to solve these many problems which come up, tests of the effluent were made twice each day, and tabulated, and by this means the results of the different experiments could be studied, and the necessary changes in operation made.

The efficiency of the filter states the report of the Department for 1918 is now as complete as could be reasonably expected. The following methods were found most desirable for removing the accumulations of iron and manganese, etc., from the tricklers and filters.

The tricklers are cleaned by flushing as follows: First, the outlet and inlet gates are closed, and all the spraying caps removed. Then the flushing gates in opposite sides of tricklers are opened, which allows the water to run to waste. The second step is to turn the combined flow of all the tricklers through this one, which so increases the amount of water passing through the coke, that in the course of one-half to three-quarters of an hour, a larger part of the various accumulations is removed. Each trickler is flushed [illegible] days.

The sand filters are cleaned in this way. After the water [illegible], about ½ in. of sand [illegible] carefully scraped off, and thrown out by a water ejector directly into a washer. As fast as the sand is washed, it is returned to the filter again. The length of time for scraping, washing, returning and placing [illegible] one day, although this has been done in 6 hours. Each bed will filter about 50,000,000 gal. between scrapings.

The filters at the time of the report had been in operation about 16 months. The tricklers showed no signs of clogging, and the iron did not appear to penetrate the sand farther [illegible] is Superintendent of Water [illegible]

Results of Experiments With Miles Acid Process of Sewage Treatment

An interesting resume of the results of various studies and experiments with the Miles acid process of sewage treatment was given by Edgar S. Dorr, Engineer of Sewer Service of the Public Works Department of Boston, and Robert Spurr Weston, of Weston & Sampson, Consulting Engineers, Boston, in a paper presented last January before the Boston Society of Civil Engineers. The paper is printed in the April Journal of the Society, from which the matter following is abstracted:

Experiments of Boston and Massachusetts Institute of Technology. Experiments conducted by E. S. Dorr, and by other officers of the Sewer Division of the city of Boston, were made at different times between June 20, 1911, and June 29, 1914. In all, eleven runs were made at different times during the four years, and 25,986 gal. of sewage were treated. The quantities of products recovered per 1,000,000 gal. of Boston sewage during those experiments were, as average, 1,738 lb. of dry sludge, containing 21.7 per cent, or 436 lb. of grease, and 1,361 lb. of fertilizer base, having an ammonia content of 4.5 per cent.

In 1915 a large-scale experiment was conducted by the Massachusetts Institute of Technology at the joint expense of the city of Boston and the Sanitary Research Laboratory of the Institute. In the Technology experiments* two continuous runs were made, one of seven days in July, and one of three days in November, 1915; and the volume of sewage treated averaged 8,241 gal. daily. The results obtained during the city's experiments were almost duplicated, as Table I shows.

Experiments at Chicago. During the summer of 1914 Langdon Pearse, division engineer of the sanitary district of Chicago, made experiments to learn whether acidification could increase the yield of fat from the Center Ave. sewage. Tests in barrels and in a tank holding about 1,500 gal. were made under his direction. A 3-hour period of subsidence was used, and the alkaline sewage required about 3,200 lb. of 100 per cent H_2SO_4 per 1,000,000 gal. Sulphur dioxide was not tried.

Pearse's results showed that acid treatment produced a higher recovery of fat, namely 69 per cent of that in the sewage as compared with 47 per cent obtained by plain subsidence for three hours. The sludge, which amounted to 2,275 lb. per million gal., contained, on an average, 93 per cent of moisture and 25 per cent of fats. The results also showed a great reduction in oxygen demand—170 per cent of that obtained by an Emscher tank. They also showed a removal of 71 per cent of the suspended matter.

The New Haven Experiments.—Much more extensive experiments have been conducted by Prof. C.-E. A. Winslow of the Yale University Medical School, and Dr. F. W. Mohlman, now chemist of the Connecticut State Department of Health. The experiments were conducted at New Haven under the auspices of a special committee, and consisted of four long-time runs with the sewage from the East St. sewer, and one run with that from the Boulevard sewer, the former runs varying from 24 to 70 days, the latter being 29 days' duration. Alongside the experiments with the Miles acid process, there were conducted experiments with screens, with the activated sludge process, and with Imhoff tanks and with plain subsiding basins, with and without chlorine disinfection.

In the experiments with the Miles process, the sewage was acidified with sulphur-dioxide gas, and a four-hour period of

TABLE I—COMPARISON OF AVERAGE RESULTS OF TREATING SEWAGE WITH SULPHUROUS ACID AS SHOWN IN EXPERIMENTS BY E. S. DORR AND M. I. T. SANITARY RESEARCH LABORATORY, 1911-1914 AND 1915, RESPECTIVELY

	Experiments by E. S. Dorr	Experiments by M. I. T. Sanitary Research Laboratory
Average daily flow of sewage during experiments, gallons	92,514,647	103,498,049
Average amount of dry sludge, pounds per million gallons of sewage	1,738	[illegible]
Average percentage of grease in dry sludge	21.7	22.66
Average amount of grease precipitated from sewage, pounds per million gallons	436	401
Average amount of sulphur dioxide used in process, per million gallons	*2,300	[illegible]

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*See Engineering and Contracting, April 11, 1917.

subsidence was provided. The alkalinity of the East St. sewage was very low, so that it was necessary, to secure an excess of acidity of 50 p.p.m., to add only 700 lb. of gas per million gal. of sewage treated. With the Boulevard sewage, 1,130 lb. of acid per million gal. of sewage were required to secure the same excess acidity (computed in terms of calcium carbonate).

The treatment removed from 61 per cent to 66 per cent of the total suspended, and 90 per cent of the settleable solids. The removal of bacteria was all that could be desired, the two last experiments, with the East St. and Boulevard sewages respectively, indicating removals of over 99 per cent of the total bacteria, and of the gas-forming organisms.

The use of acid accelerated the precipitation of the suspended solids by about 50 per cent, only 40 per cent being removed from the untreated sewage by plain subsidence as compared with 60 per cent when the Miles process was used. The data regarding the production of sludge are given in Table II.

Opposed to these very favorable results is the presence in the grease extracted from the sludge of a large proportion of unsaponifiable material (waxes, mineral oils and similar substances). Substances of this kind are practically worthless, and their removal is attended with a great deal of expense. The sludge from the East St. sewers contained 24 per cent of grease, 46 per cent of tankage and 28 per cent of water. The grease had the following composition:

	Per Cent.
Moisture and volatile matter	11.0
Unsaponifiable material	21.1
Free fatty acids	40.2
Neutral grease	22.3
Insoluble soap	5.3
Per cent of grease as free fatty acids	41.1

The degreased sludge had the following composition:

Ammonia	3.91 per cent
Phosphoric acid, P_2O_5	0.96 per cent

Winslow and Mohlman are advised by experienced users of grease that it would be necessary to distill the crude extracted product in order to produce a salable grease. This fact has been recognized, and, on the basis of distillation experiments, they estimate that the grease in the East St. sewage would be worth $5.00, and the fertilizer $2.09 per million gal.—a total of $7.09, net,—while the grease value of the Boulevard sewage would be $8.50, and the fertilizer value $2.88 per 1,000,000 gal.—a total of $11.38, net.

TABLE II—CHARACTER OF MILES ACID SLUDGE AT NEW HAVEN

	East Street Sewer.				Boulevard Sewer.
Length of run	25 days	24 days	11 days	30 days	23 days
Total gallons sewage treated	260,000	239,400	[illegible]	602,220	145,500
Pounds of wet sludge per mil. gals. sewage	3,750	4,025	3,200	2,600	5,375
Specific gravity	[illegible]	1,058	1,054	1,061	
Per cent moisture	86.6	88	86.3	85.7	92.5
Pounds dry sludge per mil. gals. sewage	[illegible]	483	439	368	403
Ether extract per cent dry sludge	23.7	24.0	29	32.6	30.9
Ether extract pounds per mil. gals.	119	116	127	120	124
Volatile matter, per cent dry sludge	[illegible]	51.2	57.3	63.8	78.5
Nitrogen, per cent dry sludge	1.6	1.6	2.4	2.0	[illegible]

TABLE III—ESTIMATED COST OF TREATMENT OF EAST STREET SEWAGE. DOLLARS PER MILLION GALLONS.

	Miles Acid Process.	Imhoff Tanks and Chlorination.	Fine Screens and Chlorination.
Tanks and buildings (interest and depreciation)	$2.47	$5.28	$4.60
Acid treatment	6.93		
Drying sludge	2.09	....	....
Degreasing sludge	1.78	....	....
Redrying sludge	.17	....	....
Superintendence	1.[illegible]6	.46	.46
Labor on tanks and screens	1.0[illegible]	1.20	1.42
Disposal of sludge or screenings		1.00	.50
Chlorination	....	4.05	4.05
Gross cost	[illegible]	11.99	11.03
Revenue	[illegible]		....
Net cost	[illegible]	11.99	11.03

TABLE IV—ESTIMATED COST OF TREATMENT OF BOULEVARD SEWAGE. DOLLARS PER MILLION GALLONS.

	Miles Acid. Process.	Imhoff Tanks and Chlorination.	Fine Screening and Chlorination.
Tanks and buildings (interest and depreciation)	$2.47	$4.44	$4.60
Acid treatment	10.74		....
Drying sludge	2.04		....
Degreasing sludge	1.91		....
Redrying tankage	.17	....	....
Superintendence	2.65	1.15	1.15
Labor on tanks and screens	1.00	1.50	2.05
Disposal of sludge or screenings		1.00	.50
Chlorination		4.05	4.05
Gross cost	20.98	12.14	12.35
Revenue	10.63	....	....
Net cost	10.[illegible]2	12.14	12.35

Conditions at New Haven are such that the effluent must be clarified and disinfected, but not necessarily nitrified. These conditions are favorable to the Miles process, to Imhoff tanks combined with chlorination, and to fine screening combined with chlorination, respectively. The activated sludge process would not work because of the presence of copper salts in the sewage.

The operation costs of the disposal plant are estimated in Tables III and IV.

Table III.—Estimated cost of treatment of East St. sewage. Dollars per 1,000,000 gal.

The results of these experiments have warranted the New Haven Committee in recommending the Miles process for adoption by the city of New Haven, and that a plant be built first at the East St. sewer, which discharges 16,000,000 gal. daily, and, if this plant be successful, the sewage from the other outfalls should be treated.

Deoxygenating Effect of Effluent from Mills Acid Process.—F. W. Mohlman† states that the effluent containing as it does bisulphites and free sulphur dioxide, has the power of deoxygenating several volumes of diluting water, and apprehends that a zone of deoxygenated water will be formed about the point of discharge of the acid effluent. Although not so stated, the implication is that such a zone might cause a nuisance or be injurious to fish life. Otherwise there would be no need for considering it a danger. The question raised is whether or not effects would be produced which would call for the aëration of the effluent. Mohlman's laboratory experiments show the effect upon the dissolved oxygen and sulphur dioxide contents of diluting the Miles process effluent with varying volumes of New Haven harbor water. The results are given in Table V.

This table shows that in a dilution of 2 of harbor water to 1 of effluent, the oxygen is reduced from 12 parts to 1 part per million, and the sulphur dioxide from 118 to 8 parts. At a dilution of 4 to 1, the oxygen is decreased five times, and the sulphur dioxide has disappeared. At a dilution of 9 to 1, the oxygen is 73 per cent, and at a dilution of 19 to 1, 92 per cent restored.

Polluted waters produce nuisances when they putrefy and give off the products of the decomposition of organic matter containing sulphur. They putrefy if the oxygen is exhausted before the organic matter is oxidized. In other words, the bacteria will oxidize the organic matter to the limit of the oxygen, and if any organic matter remains, the bacteria of putrefaction will attack it and produce the well-known conditions.

The Miles acid effluent does not represent the same conditions as those which exist in a deoxygenated, polluted water, because in the case of the effluent the deoxygenation has been produced chemically, not biologically, and the organic matter present has been practically sterilized. Furthermore, the settleable solids which might form sludge banks near the point of discharge have been largely removed. Before a nuisance can occur, bacteria must be introduced and be given a chance to multiply. Meanwhile dispersion and dilution are doing their work, and reaëration is taking place. Then there exists the condition of a warm, practically sterile effluent, free from sludge-forming suspended matter, being discharged into a considerable body of water, to the surface of which it will tend to rise and spread in a thin layer, thereby becoming subject to the reaërating effect of the wind, currents, passing craft, etc.

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†See Engineering and Contracting, Aug. 14, 1918.

TABLE V—MIXTURE OF HARBOR WATER AND MILES EFFLUENT

	Effluent.	Harbor Water.	1 Eff. to 2 Water.	1 Eff. to 4 Water.	1 Eff. to 9 Water.	1 Eff. to 19 Water.
Dissolved oxygen	0.8	12.0	1.0	5.0	8.8	11.0
Sulphur dioxide	118	0	8	0	0	0

TABLE VI—CONTINUOUS AERATION OF MILES EFFLUENT

Date	Sulphur Dioxide. P.P.M. Influent.	Effluent.	Reduction, Per Cent.	Air per Gal. Cu. Ft.
March [illegible], 1918	[illegible]	[illegible]	[illegible]	[illegible]
March [illegible], 1918	[illegible]	[illegible]	[illegible]	[illegible]
March 8, 1918	72.3	14.4	80	0.11
March 9, 1918	69.1	5.2	92	0.10
March 10, 1918	81	[illegible]	[illegible]	[illegible]
March 11, 1918	[illegible]	[illegible]	[illegible]	[illegible]
March 31, 1918	53.8	10.2	81	0.10
April 1, 1918	108.5	37.4	65	0.10
April [illegible], 1918	[illegible]	[illegible]	[illegible]	[illegible]
April 3, 1918	71.0	19.8	72	0.10
April 4, 1918	92.2	4.5	95	0.10
Average	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] that the sulphur dioxide may be removed [illegible] with tap water and after aeration the effluent will not [illegible] large volumes of diluting water. The average results of various aeration experiments using compressed air admitted through a "Filtros" plate [illegible] tank providing a detention period of [illegible] are shown in Table VI.

From the results of these experiments Mohlman concludes that [illegible] per cent of the free sulphur dioxide may be removed by blowing the effluent in a shallow tank with [illegible] cu. ft. of free air per million gal. of sewage. This degree of aeration is [illegible] of the [illegible] cu. ft. per gal. commonly used in connection with the activated sludge process.

[illegible] and M. C. Whipple, and others have shown that the aeration of water, which is in this case the [illegible] of oxygen and [illegible] dioxide, may be accomplished more economically by the use of riffles, sprays or cascades, than by aëration with compressed air. The latter method is rarely if ever used in water-works practice. In the case of the Miles effluent we believe that a sufficient degree of reaeration could be secured by discharging the effluent over a series of riffles, or, if that plan were impracticable, or passing the effluent through a suitable aerator, in the latter case at a cost of less than $1.00 per million gal.

Fish life would hardly be affected, for the only place where fish could get into any considerable depth of deoxygenated water would be close to the outlet. Elsewhere they would not be affected unless they swam on the surface, which fish would not do ordinarily.

Pearse's statement in connection with experiments at Chicago—namely, that the acid effluent has a lower oxygen requirement than ordinary tank effluent—is evidence that, while the effluent contains no oxygen, less is required for the oxidation of the remaining organic matter than in the case of settled sewage.

It is therefore our opinion that under ordinary conditions of discharge into rivers or harbors, the dispersion, dilution and reaeration of the acid effluent would be much more rapid than the development of putrefaction and consequent nuisance; and in rare cases where aëration might be necessary it could be accomplished at a cost which would not militate against the usefulness of the process.

The value of the grease from the Boulevard sewage is estimated at 8.5 ct. per lb. to the producer. This is the judgment of the Falk Co. of Pittsburgh, who distilled a sample of considerable size. This is about one-half the current price of good, saponifiable grease, containing less than 4 per cent of unsaponifiable matter. Evidently the value which has been assigned to the recovered grease in previous statements regarding the economy of the Miles process should be correspondingly reduced.

Massachusetts State Experiments.—A report on the Miles process was made by Messrs. Goodnough and Clark of the Massachusetts State Department of Health to a commission appointed by the legislature, and presented by that commission to the legislature early in 1918. As this report is made by a Massachusetts commission, and because its conclusions are contrary to the New Haven results, we believe it warrants discussion.

The experiments of Goodnough and Clark were made with three 2-gal. samples made up of aliquot hourly portions collected one day each week for several weeks. The sampling was apparently fair, but on account of the infrequency of the samples could not have been as truly representative as the portions of sewage used during the tests made by the Massachusetts Institute of Technology, amounting to 100,000 gal. of sewage. The small samples of sewage were acidulated with sulphur dioxide gas, settled, and the sludge collected and analyzed. While it is true that the sewage was treated with acid, enough departures were made from the Miles process so that it can hardly be called a test of that process.

The results compared with the Technology experiments show that 61 per cent as much acid was used and 75 per cent as much sludge; and 79 per cent as much grease was recovered. These lower results may have been due either to a weaker sewage or to insufficient acidification. But the most radical departure from the Miles process was in the use of an 18-hour period of subsidence in place of the 4-hour period used in the Miles process. Using the longer period of subsidence, the state authorities came to the conclusion that there was not enough difference (25 per cent) between the amounts of sludge obtained to pay for the acid used. In this conclusion no attention was paid to one of the cardinal points of the Miles process, namely, that acid is used to accelerate precipitation; therefore it was hardly fair to compare it with an 18-hour period of subsidence, particularly so because no engineer would ever consider the use of so long a period of plain subsidence for the treatment of sewage. The plan would be prohibited by the initial costs of the work, the local nuisances produced, and the small amount of purification effected by the treatment. Conditions at Moon Island—where sewage is stored about four hours, on an average—which are bad enough, only approach those which would exist were sewage stored 18 hours before discharge, and it is abhorrent to contemplate what the conditions would be if the sludge from these tanks could not be discharged with the sewage, but had to be otherwise disposed of. These were the conditions which in a great measure prevented the success of the plant at Cassel, Germany.

Apparently the report of the Massachusetts commission attaches little importance to the sterilizing effect of the sulphur dioxide and the absence of local nuisance, although that point was brought out in the report of the experiments conducted by the Massachusetts Institute of Technology. Furthermore, Winslow and Mohlman state that "it is particularly important from the point of view of the practical sewage-works operator to note that both effluent and sludge were so affected by the acid present as to be stable for considerable periods, so that with a plant of this type no local nuisances need be anticipated. During the whole period of our experience there were only one or two occasions on which slight signs of septic action were noticed in the tank, and the sludge was stored in barrels for weeks without the production of offensive odors." They also state that "above all, however, the thing that counts most heavily in favor of the Miles process under the conditions obtaining at New Haven is its freedom from nuisance."

In view of the local nuisance produced by many a bacterial tank and filter, we believe the stability and freedom from nuisance of the Miles process effluent and sludge are worthy of all the consideration which previous experimenters, with the exception of Messrs. Goodnough and Clark, have given it.

The Practicability of the Miles Process for Boston Sewage.—It is interesting to apply the New Haven estimates of cost to the results of the experiments with Boston sewage which have been made under our direction. These experiments showed that Boston sewage yielded about 1,500 lb. of degreased tankage, containing 4.53 per cent of ammonia; also about 400 lb. of recoverable grease per million gal. With fertilizer ammonia at $4.00 per unit, the tankage is worth $18.12 per ton, or $13.59 per million gal. of sewage. Using 8.5 ct. as the price per pound for the recovered grease (which seems fair because this was the estimated value of the New Haven Boulevard sewage which contains about the same percentage of unsaponifiable matter as the Boston sewage), the grease would be worth $34 per million gal.

Modifying the New Haven costs to correspond with the stronger Boston sewage, we have determined the costs as given in Table VII, which also shows the costs of treatment of the Boulevard sewage of New Haven. We have not used the East St. sewage for comparison because it is not representative; it contains an unusual amount of machine oils and wastes from the metal industries.

In applying the New Haven unit costs we have made no subtraction on account of the larger plant or the available tanks at Moon Island. Unit costs for all items except superintendence and labor are those used for Boulevard sewage; the unit costs for superintendence and labor are those used for East St. sewage.

The estimated net financial result of operation is given in Table VIII.

TABLE VII—COST PER MILLION GALLONS OF TREATING 100,000,000 GALLONS OF CALF PASTURE SEWAGE DAILY, APPLYING THE UNIT COSTS ESTIMATED BY WINSLOW AND MOHLMAN FOR 16,000,000 GALLONS OF NEW HAVEN SEWAGE DAILY.

	Calf Pasture Sewage.	Boulevard Sewage.
Tanks and buildings	$2.47	$2.47
Acid treatment	18.65	10.74
Drying sludge	10.35	2.04
Degreasing sludge	9.12	1.91
Redrying tankage	.10	.17
Superintendence	1.06	2.65
Labor on tanks and screens	1.00	1.00
Total cost per million gals.	$42.75	$20.98

In the above we have estimated the price of ammonia at $4 per unit. This is low at present. When ammonia is worth $4.50 a unit, the gross revenue would be $49.29, and the profit $6.54 per million gal., and at $4.75 per unit, the gross revenue would be $50.14 and the profit $7.39 per million gal. While the above estimate shows a profit under present conditions, it is probably true that under pre-war conditions the process would not produce a revenue; and in their conclusion Winslow and Mohlman state that "our experience with New Haven sewage lends no color to the hope that a net financial profit can be obtained by the use of the Miles acid process, unless with sewage of exceptionally high grease content and low alkalinity."

One may rightly question the values of any conclusions based on pre-war prices, because the present evidences indicate that the prevailing prices will not be lowered immediately, and they may never reach their pre-war level. This is particularly true of labor, which is the principal factor in the costs of materials. At present high prices it seems as if the Miles process would be profitable at Boston, and this favorable condition would gradually disappear as the rate of fall in prices exceeding the rate of fall in cost of operation comes into effect.

The materials produced are fertilizer and grease, and it does not seem likely that the demand will decrease rapidly. The materials used for purification are sulphur, pyrite, niter cake and the sulphur acids. The war has stimulated the production of all these materials, and now that the abnormal demand had ceased they should be cheap.

Therefore we feel that in many cases it is likely that the Miles process might be operated at a slight profit for some time to come, and, in any event, operated at a cost lower than that for any other process producing the same grade of clarification and disinfection.

Other Advantages of the Miles Process.—In addition to the advantage due to the freedom from nuisance, the stability of effluent and sludge, and those due to the compensating value of the recovered products, there are still other advantages which should be reckoned with.

All are aware that modern sanitary engineers are designing sewage disposal works to purify sewage to the degree to which the body of water into which the effluent is to be discharged demands and as the financial conditions will allow. In so doing they often sacrifice a desirable degree of clarification, as when only subsiding basins or screens are used; or a high degree of nitrification, as when high rates of filtration through coarse material are employed; but with the Miles process it is a fundamental necessity, in order to recover the valuable products upon which the cheapness of the process depends, to at the same time disinfect the effluent and attain a much higher degree of clarification than can be obtained by screening or plain subsidence. Therefore there is little temptation to sacrifice safety for cheapness.

The sludge from the Miles process contains much less moisture than activated sludge, and about the same as the subsiding basin sludge and the Imhoff tank sludge, as Table IX shows.

As compared with activated sludge, the advantage of handling less than one-seventh of the volume of activated sludge is obvious.

Installation Cost for Miles Process.—The devices required for the operation of the Miles process are the following:

Devices for producing sulphur-dioxide gas, and for feeding niter cake or other forms of acid.

Subsiding basins.
Sludge-handling apparatus.
Sludge driers.
Grease extractors.
Grease stills.
Tankage driers and grinders.

While the list is formidable and is enough to rule out the process for small plants, in the case of a city like Boston, however, the cost should not exceed $15,000 per million gal., daily capacity.

TABLE VIII.—ESTIMATED FINANCIAL RESULTS OF OPERATING THE MILES ACID PROCESS AT THE CALF PASTURE.

	Per Million Gallons.
Revenue:	
From tankage	$13.59
From grease	34.00
Total gross revenue	$47.59
Expenses:	
Estimated cost of treatment	42.75
Profit on above basis	$ 4.84

TABLE IX.

Kind of Sludge.	Average Percentage of Moisture in Slude.	Relative Volumes of Sludges Containing the Same Amounts of Dry Matter.
Activated sludge	98.5	100
Subsiding basin sludge	91.5	18
Miles Process sludge	90.0	15
Imhoff tank sludge	89.0	13.6

Large Scale Experiments Necessary. While all of the large-scale trials of the process have been giving promising results, it is true that the drying and degreasing of sludge has never been practiced on a large scale. All of the estimates are based upon small-scale trials and the opinions of engineers and of manufacturers who have handled similar materials. There is great need, therefore, for a large-scale experiment with normal sewage to determine the actual possibilities in practice. This experiment should be made on a scale large enough to determine beyond all doubt the costs of drying and degreasing and the possibility of marketing the products. It might cost $50,000.

Adaptability of the Process.—In the words of Winslow and Mohlman,—"For communities where clarification and disinfection are desirable,—where screening would be insufficient and nitrification unnecessary,—the process of acid treatment comes fairly into competition with other forms of tank treatment; and that it is particularly suited to dealing with sewages which contain industrial wastes and for use in localities where local nuisances must be avoided at all costs and where sludge disposal could be provided for only with difficulty." This means that in 90 per cent of the cases where a large volume of strong sewage is discharged, the Miles process is worthy of consideration.

Conclusions.—We conclude the following from the results of the various experiments and studies:

(1) The Miles process will produce a well disinfected effluent from which 90 per cent of the settleable solids have been removed.

(2) Whereas it requires for its accomplishment devices for the chemical treatment of the sewage and for drying and degreasing the sludge, competent supervision is necessary.

(3) On account of the nature of the plant and the relatively high cost of operation for small installations, it is not well adapted for the purification of small volumes of sewage.

(4) Its operation should cause no local nuisances.

(5) It causes the removal of over 99 per cent of the bacteria.

(6) The effluent remains stable long enough for the neutralization of the excess acid, and the oxidation of the sulphites and the sulphates by dilution.

(7) As compared with the activated sludge process, the volume of sludge is very small.

(8) Compared with the cost of the oxidation processes, the cost of installation is low; it is somewhat higher than that for Imhoff tanks with chlorination.

(9) The products recovered are valuable, and their recovery would effect a conservation of natural resources.

(10 Apparently it is the most economical process for producing so well clarified and so stable an effluent, and under present conditions it seems as if it could be installed and operated at a profit in those larger cities where the conditions are favorable.

(11) To determine the costs of sludge drying and degreasing more accurately than is possible from the available data, a large-scale experiment is urgently needed.

Water Consumption at New Bedford, Mass., in 1918.—The average daily water consumption in 1918 of New Bedford, Mass. (118,140 population supplied), was 3,759,405 gal., or 82 gal. per day to each inhabitant, or 621 gal. per tap. The consumption is 83 per cent metered. Of the total consumption domestic consumers used 34¼ per cent, and manufacturers 51 8/10 per cent. The remaining 14 per cent is unaccounted for. The cost of supplying water per 1,000,000 gal. figured on total maintenance was $48.73. The total cost of supplying water, per 1,000,000 gal. figured on total maintenance plus interest on bonds, was $69.08.

Future Public Water Supplies in Iowa*

[illegible]

[illegible]

[illegible] public [illegible] of such [illegible] of the [illegible] the valleys of such [illegible] mit the collection of the water supply by driven wells, tubular wells, dug wells, or by the gallery system. It is a discouraging fact, however, that very few of the gravel beds lying in our river valleys or adjacent to the streams are [illegible] driven wells. A somewhat larger number will afford the supply by means of tubular wells. However, not many of such locations permit extensive collection of water by means of dug wells and there is only an occasional location where the gallery [illegible] effective.

Instances of the failure of driven wells are numerous, although a number of our municipalities are still depending upon such method of collection, preferring to keep up a continual cleaning and replacement of wells rather than to resort to more modern methods. Instances of apparently successful collection by means of shallow tubular wells are not infrequent. Perhaps the largest inland supply furnished by such means of collection is at Newton, Ia., where tubular wells from 6 in. to 8 in. in diameter and about 50 ft. in depth, located in the valley of the Skunk River, about 6 miles from the city, furnish an apparently inexhaustible supply of excellent water. In this particular instance, it would appear to be only a question of multiplying the number of wells and increasing the supply main leading to the city in order to furnish an unlimited supply for the use of the city of Newton, no matter how large the city may become in the future.

However, where it is possible to economically collect a water supply from a river valley by these methods, the supply should be so collected and the water given whatever treatment may be necessary to make it safe and suitable for domestic use. Such treatment may consist of nothing more than chlorination to eliminate pathogenic germs, but it may include, and must necessarily in some locations include the removal of the iron content which is almost always present in such waters, and it may also require some treatment to reduce the hardness.

Where it is not possible to economically collect the public water supply of a river valley by means of the foregoing methods, the final chance is the use of the water of the river itself. It is, of course, understood in such a case that modern methods of purification and filtration will be employed, but the efficiency of such methods is long past the experimental stage and is now recognized as an accomplished fact.

Recent instances of the necessity for such use of stream water are the city of Clarinda, which in times past has depended upon shallow tubular wells and which now contemplates taking the stream water and purifying the same by means of a modern mechanical filter plant and the city of Ft. Dodge, which is now contemplating a supply taken directly from the Des Moines River and likewise purifying the same by means of a modern, mechanical filter plant.

The future history of the public water supplies in Iowa will find many such instances of abandonment of the present methods of collection of public water supply and the institution of direct river supplies.

In any locality where neither shallow nor deep wells are successful and where an adequate river or lake supply is wanting, apparently the only source of public water supply will be the catchment area and the impounding reservoir.

This proposition demands at once a consideration of the rainfall and the run-off, the topography, the character of the soil and the surface pollution.

It is common to place the annual precipitation in the state of Iowa at approximately 30 in. A closer examination of data reveals that the annual precipitation in the northwest corner of the state is 25 in., and in the southeast corner of the state between 35 and 40 in.

Lines of equal precipitation plotted upon the map would show the 25-in. line running through the center of Lyon County near Rock Rapids and extending in a northeasterly and southwesterly direction. The 30-in. line enters the state at Council Bluffs in Pottawattamie County runs northeasterly to Rockwell City, thence to Ft. Dodge, thence to Waverly, thence in a more northeasterly direction to Decorah and crosses the state line within, and near the northwest corner of, Allamakee County. The 35-in. line enters the state in Ringgold County, thence runs northeasterly to Leon, Eldon, Fairfield, Washington, Tipton, and crosses the state line and the Mississippi River at Dubuque, thence running almost due east in the state of Illinois. The 40-in. line is entirely south and east of the boundaries of the state.

The foregoing review of the annual precipitation will indicate that those localities of the state where impounding must be employed are, generally speaking, the portions of the state where the heaviest rainfall occurs.

A study of the topography of the state and the rainfall determines that in certain portions of the state perhaps 75 per cent of the rainfall enters the soil and 25 per cent becomes run-off, while in other portions of the state perhaps not more than 25 per cent of the rainfall enters the soil and 75 per cent of the rainfall is run-off.

Ordinarily in localities where impounding must be employed the run-off is more than 50 per cent of the rainfall. Barring dry periods and years of scant precipitation, the topography of the state and the character of the soil in these localities are favorable for the use of catchment areas and impounding reservoirs.

Instances of the successful collection of public water supplies by such method are Centerville and Chariton, both of which cities exhausted all possibility of obtaining public water supplies by means of deep wells and have now succeeded in obtaining satisfactory supplies by the method of impounding and treating water. A number of other municipalities in Southern Iowa have adopted this plan more or less successfully and it is evident that in Southern Iowa the future public water supplies will be largely impounded where streams are not available.

Primarily the rainfall furnishes our water supplies no matter what the method of collection. It is true, however, that our attention is directed to the question of rainfall more anxiously in the case of impounded supplies because such supplies are almost wholly made up of run-off water.

A few mistakes have been made locally in estimating the required area of water shed. In certain localities it may not be wise to consider that more than 6 in. of the annual rainfall may be available after allowing for rapid run-off, evaporation and percolation. In other localities the effective amount may be 8 in. or more. By computation of volume of supply based upon utilized rainfall, the area of water shed may be determined. An effective recovery of 6 in. of rainfall per square mile would provide for a daily supply of approximately 300,000 gal.

We may therefore summarize the probable future practice in locating and installing future public water supplies in Iowa as follows:

1. Supplies from rivers and lakes.
2. Supplies from catchment areas and impounding reservoirs where streams and lakes are not available.
3. Supplies from wells in localities where streams and lakes and catchment areas are not available.

It would appear to be possible to collect and purify the stream and lake water and the impounded water of the state at a cost not exceeding $25 per 1,000,000 gal., except during flood times or times when silt and surface pollution are maximum. This would mean a cost of 2½ ct. per 1,000 gal.; and under abnormal prices we might estimate the cost of the collection and purification at 5 ct. per 1,000 gal. It would appear, therefore, that the actual cost of collection and purification is one of the minor costs of a safe, sanitary and satisfactory public water supply.

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*[illegible] Iowa Section, [illegible]

Testing Stations for Determining Critical Factors for Water Purification Plant Design*

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Design and Construction of Testing Stations.—The size of the testing station which it is advisable to build depends on the nature of the tests and the funds available. In general, a testing station is a minature replica of a complete purification plant. Sometimes, however, the tests are run on parts of a completed plant prior to enlargement or a portion of one of the component parts of a plant is built in advance for test purposes. This method deserves attention and is to be tried out on a sewage treatment plant at Decatur, Ill. It is planned to build two small sprinkling filter units and to use them as a testing station. These units will establish rates of application and any other factors necessary to be determined before the time when full sized units for all the city's sewage can be built. When this is done, these two sprinkling filter units will become a part of the completed plant.

When basic engineering principles are already well established and it is necessary to determine only the rates and areas required to make these principles applicable to local conditions, this method of testing would seem to offer great possibilities, first, because full sized units can be used for the tests, and second, because the testing station can very often be built out of funds already appropriated for partial or complete treatment.

When a small testing station is to be built, the purpose of the tests should be kept clearly in mind, and the limitations of a small station should be considered. A test run to investigate color removal, for instance, needs only prove that it is possible to remove color. It is not necessary to produce absolutely sterile water in the testing station itself for experience has shown that it is much more difficult to get sterile water from a small test filter than from the larger units used in regular filtration work. As long as the test demonstrates that the color can be removed and shows how it is to be done the plant has accomplished its mission.

A testing station should be compact, convenient, and easy of access to all parts. As far as practicable the course of the water through the plant should be progressive. Each step in the treatment process should be in logical sequence in order that the work of the operator may be simplified and that it may be easier to watch and understand. This is particularly important when the operator is a non-technical man. An operating platform is convenient and desirable.

The designer should keep in mind that a plant of this kind is often subjected to quite radical changes. The baffling and piping arrangements are most often affected and the chemical used for treating purposes may have to be changed also. In this case, a change in the method of applying or in its point of application may be required.

Because of the temporary character of a testing station, the first cost is relatively very important, while durability of material and cost of operation are not so important. Wooden construction therefore is quite suitable, sheet iron is useful and black iron pipe is often satisfactory. The salvage value after the plant is dismantled may, however, call for better material than would otherwise be used. Obviously, the material and construction should be substantial and good enough to give satisfactory service and to last throughout the period of test.

Recently the firm of Pearse & Greeley have designed and built two small testing stations to study unusual problems in water purification. One of these was installed at Whiting, Ind., the other is at Midland, Mich. They are both good examples and show the value of such tests when little literature or experience is available.

The Whiting Testing Station.—Whiting, a city of 8,200 people, is located along the south shore of Lake Michigan in the heart of a great industrial district. Surrounding it are the cities of Indiana Harbor, East Chicago and Hammond. At present all the sewage from this great manufacturing region finds it way into Lake Michigan, but the Calumet Sag Canal promises some relief in the near future. Some of the industries produce large quantities of troublesome wastes, notably several chemical works, a glucose factory, and the great steel mills. The most troublesome waste, however, is that from the Standard Oil Refinery located in Whiting which imparts a very objectionable taste and odor to the city water. The amount of oil actually existing in the water is exceedingly small and is very difficult to detect by any chemical means. Nevertheless the effect is quite apparent to the consumer.

Most of the oil is said to come from the agitators where the motor spirits are clarified. Soda and sulphuric acid are added in this refining process and the resulting sulphates are washed out into the lake and form what is called "Soap" or "White Water." This white water carries off small quantities of oil in mechanical suspension, some in the form of an emulsion and some in colloidal solution. Portions of the oil are volatile.

The city water supply is drawn through a 66-in. brick tunnel extending out into the lake about 24,000 ft. At times the white water described above discolors the lake as far as the intake and the water is rarely without some odor or taste.

The problem for design was this—given a city water supply contaminated by a variety of unusual wastes with oil waste predominating, to design a filter plant effective in removing odors and tastes as well as the bacterial content. The purpose of the testing station was to study this problem along the following lines:

(1) The effect of aeration on the odor and taste.

(2) Kind and amount of chemical to be used and its effect on the odor and taste.

(3) Period of sedimentation and the time of contact giving best results.

(4) Any peculiarities that might develop in the treatment of water contaminated by oil.

The following is summary of details of this station:

Aeration:
Size of collecting platform, 11 ft. x 15 ft.
Nozzle used No. 5 Spraco made by Spray Engineering Co., Boston, Mass.
Pressure at base of nozzle, 8 lb.
Water rate, 8½ gal. per minute.

Chemical Treatment:
Chemical used, alum.
Admitted between aerator and coagulation basin.
Strength of stock solution, 10 per cent.
Strength of solution fed, 1¼ per cent.

Method of Feeding:
Through a small hole drilled in side of ½-in. brass tube fixed through rubber cork in bottom of wooden bucket. Head on orifice maintained by means of fountain similar to the inverted water bottle often found in offices.

Amount of Chemical Fed in Water:
Ranged from ½ grain to 1 grain per gal. of water treated.

Coagulation Basins:
Number used, 2.
Size of each basin 5 ft. 6 in. x 8 ft. x 2 ft. 9 in. deep inside measurements.
Depth of water, 31 in.
Capacity each basin 825 gal.
Capacity in hours 1 hr. 10 min. each when tanks were run in series (2 hr. 20 min. total) or 2 hr. 20 min. each when run in parallel.
Number of baffles in each tank 1 lengthwise at first with 2 passageways, later changed to have 3 baffles with 4 passageways.
Velocity of Flow:
  When run in parallel
    With single baffle, .076 ft. per min.
    With triple baffle, .172 ft. per min.
  When run in series
    With single baffle, .152 ft. per min.
    With triple baffle, .341 ft. per min.

Filter:
Number of filters, 1.
Area, 4 sq. ft.
Filtration rate, 8 gal. per min.
Underdrain system used, Harrisburg type with pipe grid.
Depth of gravel, [illegible] in.
Depth of sand, 30 in.
Wash, hand controlled from barrel storage.
Rate of wash, 15 gal. per sq. ft. per min.
[illegible] from filtered water [illegible]
Method of rate control, float valve on orifice.

Results of Test at Whiting Station.—The results of aeration showed that the improvement in the water was not at of [illegible]. The effects seemed dependent upon the direction and strength of the wind which, when it blew across the plant of the Standard Oil Co., not only caused the air to become heavily laden with oil odors but also drove before it a great deal of fine oily matter which had become coated with oil. Under such conditions the sprays actually washed oil out of the atmosphere instead of giving up that which it already contained. Nevertheless the aeration seemed helpful at all times for the water required a smaller amount of chemical to accomplish the final treatment. In the coagulation [illegible] [illegible], was probably due to a breaking down of the emulsion.

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*Abstract of a paper presented before the Illinois Section, American Waterworks Association.

Alum was the only chemical tried and it proved successful. As the oil which remained in the water after aeration was probably removed by absorption, that is, by sticking to the flocculent precipitate of alum, any other coagulant of the same general character would doubtless have done as well. It was not thought worth while to go further into the matter. A fair average of the amount of alum required was about .7 grains per gallon of water treated.

It seemed to substantiate that the period of contact, it seemed that the oil required some time to attach itself to the coagulant and when the floc was kept in suspension for a while longer than the common practice, a smaller amount of alum could do the same work.

Among the peculiarities which developed during the test, the most important was the necessity for frequent washing to maintain the normal rate of filtration. The filter acted as though it were air bound. This was probably due to the oily floc forming a water tight film over the surface of the sand, for it was discovered that by lightly raking the surface of the sand the filtering rate was restored and the loss of head returned to nearly normal. Later it was found that the same result was obtained by "shaking" the filter, i. e., by simply opening and closing the wash water valve without actually washing the filter. In this way the period of service between washings was increased from 6 to 16 hours, with a consequent reduction in the amount of wash water used.

Difficulty was also experienced in making satisfactory analyses of the samples. Since no other method was available for detecting oil in such minute quantities, appeal had to be made to the senses of taste and smell. Obviously, these senses are somewhat unreliable. However, the tests were made independently by three different persons so that the results were well checked. It was found that it was impossible to judge odors in Whiting because of the atmospheric conditions so the samples were brought to Chicago for judging. Conclusions from the tests were that the taste and odor could be thoroughly removed when the modifications of filter practice noted above were put into effect.

Midland Testing Station.—Midland is a town of about 10,000 inhabitants, and is approximately 25 miles from Saginaw. It is located near the center of a brine well district and is the home of the Dow Chemical Co., a company which utilizes this brine and other chemicals in solution to manufacture a large number of chemical products.

Two rivers, the Chippewa and the Tittabawassee, unite in Midland. The Chippewa is less turbid and colored than the Tittabawassee, but has a drainage area more thickly settled and consequently much more polluted. Both waters are fairly hard.

At present, Midland obtains its supply from the Chippewa River principally because of its clearness. On account of the rapid growth of the chemical company during war time and the consequent increase in population, the town has awakened to the necessity of improving its water supply.

The problem at Midland is in part as follows:

1. Determination of the more suitable supply, the Chippewa or the Tittabawassee river.
2. Determination of the best method of reducing the color of the Tittabawassee river, if that supply is selected.
3. Determination of the best method for reducing the alkalinity of either source.

The testing station as constructed consists essentially of two coagulating basins, a filter, and a filtered water storage tank. Supplementary to these are an inlet orifice box, a divided orifice (one portion of a flow) passing through a lime saturator and joining the other portions, a mixing trough, wash water barrels and a filter rate controller of the adjustable float type.

The supply is obtained from the river through a small electric driven centrifugal pump, and delivered to the inlet orifice box.

The following summary of the different devices furnished an outline of the essential features in the design and operation.

Chemical Treatment—
  Lime—
    Applied to raw water.
    Quantity used, approximately 8 grains per gallon.
    Method of feeding, by diverting a portion of flow (about one-tenth) through a lime saturator uniting with the remaining portion of raw water.
  Alum—
    Point of application between two coagulating basins.
    Method of feeding: a 20 liter bottle with side outlet controlled by an adjustable screw cock. A glass tube through a cork in the top which terminated in an upturned gooseneck near the bottom supplied the air and regulated the head on the outlet. This bottle was capable of very fine adjustment.
Lime Saturator—
  Size, 16 in. in diameter at the top, 4 in. in diameter at the bottom, depth, 30 in.
  Flow period, 30 minutes to 1 hour.
  Method of admitting lime, as a 10 per cent milk of lime mixed in barrel above.
Mixing Troughs—
  Number of passages, 5.
  Each passage 3 in. wide, 3 in. water depth and 6 ft. long.
  Period of mixing, approximately 3 minutes.
  Each passage was baffled with 1 in. cleats spaced 3 in. center and had a slope of 1 in. from end to end.
Coagulating Basins—
  Number used, 2.
  Size and capacity, the same as those used at Whiting.
  Period of flow used in tests, 8 hr. and 6 hr.
Filter—
  Number of filters, 1.

A small laboratory was fitted up in conjunction with the station. Alkalinity tests on the raw water, lime water, coagulated water and filtered water were run at frequent intervals. Anything wrong or unusual in the operation was apparent to the operator at once. The solutions were made up so that no computations had to be made to interpret the results.

The testing station itself was housed in and old pump house heated and lighted. This was a distinct advantage. The tests were run 24 hours of the day and thus approached actual working conditions.

Costs of Water Testing Stations.—The accompanying table of costs of Water Testing Stations will doubtless be of interest to those who contemplate such tests. The table was taken originally from "Sewage Disposal" by George W. Fuller and was revised by Langdon Pearse in his lecture, "Experimental Engineering, Particularly the Construction of Testing Stations on Water and Sewage Problems," and brought up to date by the writers:

LIST OF SPECIAL AMERICAN INVESTIGATIONS ON WATER AND SEWAGE PURIFICATION.

Place.	Date.	Work.	Cost.
Lawrence, Mass	1887-11	Water and sewage	$195,000
Providence, R. I	1893-94	Water	5,000
Louisville, Ky.	1895-97	Water	47,395
Reading, Pa.	1897	Water	1,500
Pittsburgh, Pa.	1897-98	Water	36,386
Cincinnati, O.	1898-99	Water	41,598
West Superior, Wis	1898-99	Water	2,000
Washington, D. C.	1899-1900	Water	8,000
Richmond, Va.	1900	Water	2,000
New Orleans, La	1900-01	Water	23,606
Philadelphia, Pa	1900-05	Water	172,000
Springfield, Mass	1901-03	Water	18,000
Harrisburg, Pa.	1903-04	Water	25,000
Columbus, O.	1904-05	Water and sewage	44,000
Oakland, Calif.	1907-08	Water	19,390
Ontario, Province of	1909-15	Water and sewage	61,900[1]
Detroit, Mich	1916	Water	8,050[2]
Cleveland, O.	1916	Water	4,000
Milwaukee, Wis.	1918	Water	40,000[4]
Whiting, Ind	1917	Water	1,000

[1] Includes about $14,000 for field work in province. [2] Does not include operating cost of $9,000 per year. [3] Does not include operating cost. [4] Appropriation.

CONSTRUCTION COSTS OF TESTING STATIONS.

Water.	Supply.	Total.
Baltimore	Gravity	$ 5,000
Cincinnati	Gravity	19,717[1]
		4,411[2]
Detroit	....	8,000
Harrisburg	Pumped	10,573
Jerome Park	....	7,825[4]
Milwaukee	Pumped	8,282[5]
Whiting, Ind	Pumped	500
Midland, Mich.	Pumped	400
Cleveland	Pumped	4,000

[1] Testing devices. [2] Laboratory building and equipment. [3] Including engineering inspection. [4] Low bid, exclusive of filter washing machine. [5] Exclusive of piping, heating, etc.

Diagrammatic Representation of Public Utility Commission Decisions on Fire Charges

Curves based on public utility decisions have been found useful by Chester & Fleming, Consulting Engineers, Pittsburgh, as a guide to show what portion of water charges should be allocated to fire service. The diagrams prepared by the above mentioned firm are reproduced below. Each curve is platted from 24 decisions for plants having a value above $50,000 and gross revenues from $5,000 to $100,000 per year. The decisions from which these curves were prepared are shown in the table, each division's place in the diagram being indicated by its number given in the table.

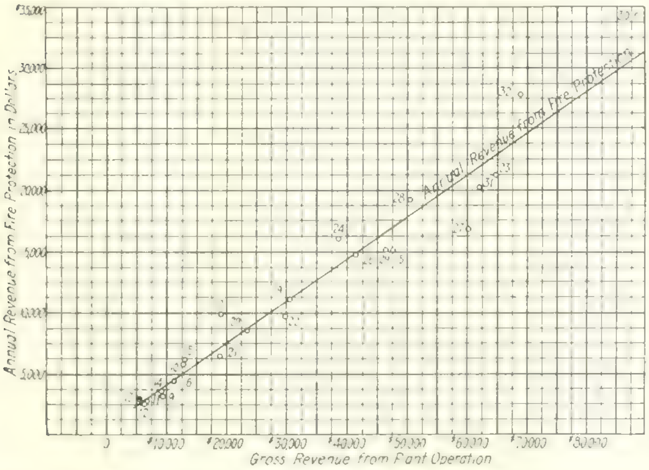

Fig. 1—Annual Charge for Fire Service by Water Works Plant.

The diagrams are self explanatory. For instance, in Fig. 1 there appears at the bottom the gross revenue from plant operation. At the left of the diagram appears the annual revenue from fire protection in dollars, which permits the location on the face of the diagram at its proper point each decision and through these decisions the line of average is drawn, and so knowing the gross revenue from plant operation one may readily obtain what the decisions plotted would indicate would be the fair amount of the gross to be derived from the municipality as compensation for fire protection.

Figure 2 at the left of the page, instead of stating the annual revenue from fire protection in dollars, tabulates the percentage of gross revenue.

Figure 3 deals with the value of the plant as fixed by the Commission in its relation to the revenue from fire protection in dollars.

Figure 4 deals with the value of the plant as fixed by the Commission with relation to the percentage of the plant chargeable to fire protection.

By plotting the curves which represent the average of the decisions, the average result may be found within the limit of these decisions, and by utilizing the line of average extended in either direction, the results may be made useful beyond the limits embodied in the decisions.

FIRE PROTECTION CHARGES MADE AGAINST THE MUNICIPALITY BY PUBLIC UTILITY COMMISSION.

	Date of Decision	City. State.	Population 1910.	Per cent of Water Works Charged to Fire Service	Value of Plant	Gross Revenue	Revenue from Fire	Per cent of Gross Revenue from Fire
1	1913	Elkhart Lake, Wis.	950	59	$ 8,425	$	$ 600	...
2	1912	Sharon, Wis. ...	1,100	52*	....	....	1,000	.
3	1914	Waterloo, Wis. .	1,106	60	30,500	.	1,500	. .
4	1913	Fennimore, Wis. .	1,275	55*	23,046	.	1,500	. . .
5	1914	Elroy, Wis.	1,450	47.4	32,215		1,500	. .
6	1915	Barron, Wis. .	1,674	....	35,000	.. .	1,392	
7	1912	Evansville, Wis.	1,963	64.1	37,122	4,813	2,500	52
8	1914	Vaughn, Wis. .	...	53	38,000	6,860	2,800	40.8
9	1917	River Falls, Wis..	2,300	54.6	56,000	9,429*	3,240*	34.4
10	1913	Delevan, Wis....	2,450	64	42,291	6,700	2,800	41.8
11	1913	Columbus, Wis...	2,523	53.2	53,696	6,499	2,600	40
12	1910	Jefferson, Wis...	2,582	75	51,524	6,208	2,560	41.2
13	1915	Prairie du Chien, Wis	3,179	.	78,400	5,418	2,800	51.7
14	1913	Ft. Atkinson, Wis.	3,300	51	73,424	9,156	3,600	39.3
15	1910	Ripon, Wis.	3,811	65.2	103,101	12,923	6,082	47.1
16	1913	Sparta, Wis. ...	3,973	55	98,599	11,047	4,400	39.8
17	1911	Oconto, Wis. ...	5,629	57.5	125,000	19,031	9,800	51.5
18	1912	Neenah, Wis. ...	5,734	54.5	117,038	12,850	5,850	45.5
19	1916	Merrill, Wis. ...	8,689	47	200,000	30,415*	11,000	36.2
20	1914	Watertown, Wis. .	8,829	*47.2	202,677	23,394	8,500	36.3
21	1914	Brazil, Ind	9,340	70	128,383	18,987	6,361	33.5
22	1917	Lincoln, Ill . .	10,892	43	215,000	29,850	9,651	32.4
23	1914	Ashland, Wis.....	11,594	54.5	480,000	65,000	21,000	32.3
24	1911	Janesville, Wis...	13,894	54	250,000	38,725	15,800	40.8
25	1911	Marinette, Wis...	14,610	38.5	326,759	47,630	14,800	31.1
26	1911	Beloit, Wis.	15,125	48	289,512	41,565	14,687	35.3
27	1915	Beloit, Wis.	15,125	48	402,000	60,323	16,659	27.6
28	1915	Appleton, Wis. ..	16,773	45	525,000	50,616	19,000	37.5
29	1912	Eau Claire, Wis..	18,310	48.5	314,987	46,655*	15,000	32.2
30	1913	Green Bay, Wis.	25,236	48.7	683,229	88,665*	34,000	39.8
31	1910	Madison, Wis. ...	25,531	49.6	650,000	62,260	20,000	32.1
32	1914	Sheboygan, Wis..	26,398	46	507,739	69,176	27,500	39.8
33	1912	Superior, Wis. ..	40,384	46	838,242	110,146	27,900	25.3

*Estimated.

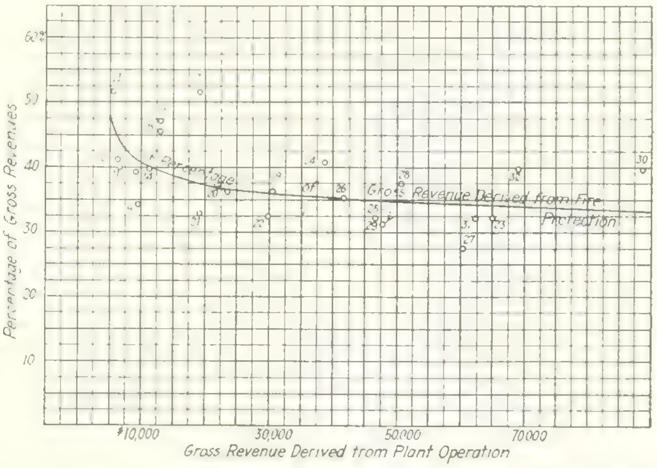

Fig. 2—Percentage of Revenue to Be Derived from Fire Protection by Water Works Plant.

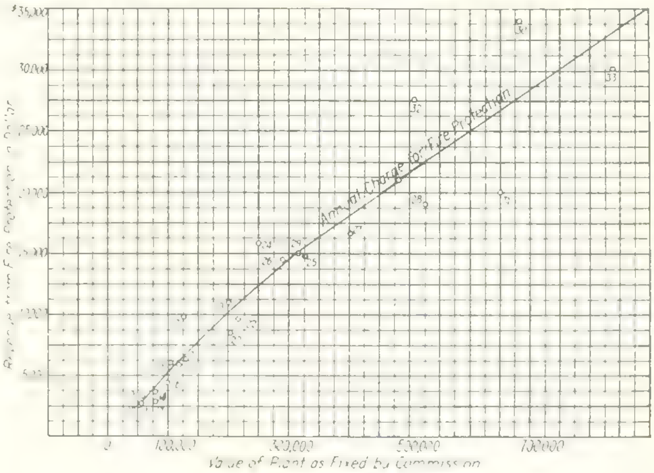

Fig. 3—Comparison of Value of Water Works Plamts and Revenue from Fire Protection.

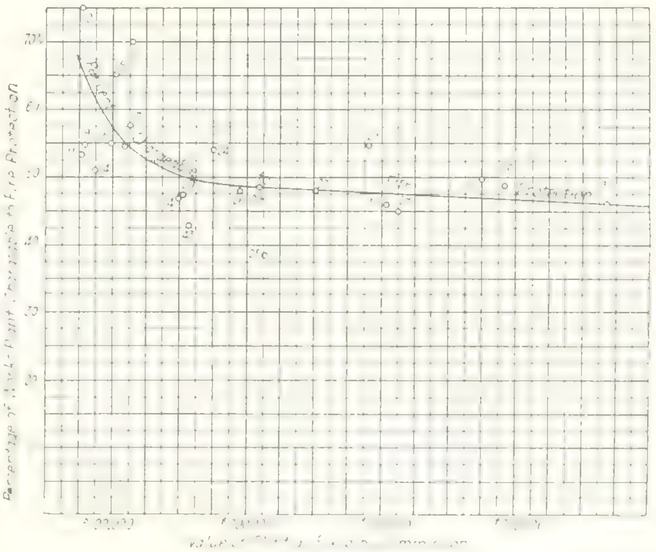

Fig. 4—Percentage of Water Works Plant Chargeable to Fire Protection.

Cost of Pumping Through Pipe Lines*

By [illegible], Acting Chief Illinois State Water Survey.

[illegible] installation it is common [illegible] of flow through the [illegible] advantage but it is probable [illegible] will water flow at such [illegible] sized pipes carrying [illegible] computed and the extra [illegible] balanced against the [illegible] officials in charge of the installation of, or changes in, a water supply would do well [illegible] through the pipe line reduced to cents per thousand gal. (or other unit by which [illegible] knowing the compara[illegible] would be given to secur[illegible] at some distance, possibly [illegible] In other instances the advantage of providing reservoir capacity to reduce fluctuations in [illegible] with large sized pipe could be more readily shown.

[illegible] water such as is in general use for public supplies is not generally affected by the velocity of flow within ordinary ranges. Therefore, to double the rate of flow divides by two the interest and depreciation change per gal. However, with increased rate of flow the friction increases, and, with same pipe line, same cost of pumping 1,000,000 gal. 1 ft. high, and not including interest and depreciation on pipe line, increasing the flow 50 per cent multiplies the total cost of pumping by three.

A pipe line built without regard to increased demand in future may result in very high pumping costs or building of another line in the near future. A line built to give economical cost of pumping 10 or 20 years in the future may be very expensive on account of high interest charged on the investment. Since in many instances it is necessary to vary the rate of pumping throughout the day, the size of pipes should be so chosen that average cost will be economical. It may be economical in some cases to pump at a definite rate for several hours each day until sufficient water is pumped to meet the demand for the entire day. Interest and depreciation continue, however, when line is not in use.

Knowing definitely the cost units, the cost may be shown best by curves, but for a basis from which to draw curves for any cost units, values are best shown by tables.

The following table is prepared to show cost of delivering water at uniform rates of flow through pipe lines. The pumping cost is taken at 10 ct. per 1,000,000 gal. 1 foot high. Friction is computed by the formula of Flamant as given by diagram in "Public Water Supplies" by Turneaure and Russell." The cost of pipe is taken at $30 per ton for Class B cast-iron pipe and interest plus depreciation on the pipe line is taken at 6 per cent.

When pumping costs are low, pumping a little above the most economical rate does not greatly increase the total cost per 1,000,000 gal. However, by choosing the next larger sized pipe the cost could, in many cases, be greatly decreased.

Costs for pumping part time at uniform rate may be computed from the table. For example, pumping through a 10-in. pipe line at a rate of 1,000,000 gal. a day, an average of 8 hours a day, the cost of pipe line per 1,000,000 gal. would be three times that given in the table, or $3.63. Operation if cost is 10 ct. per 1,000,000 gal. 1 ft. high would be $2.10 as given—total $5.63. Pumping for 8 hours at a rate of 500,000 gal. a day and for 16 hours at a rate of 1,000,000 gal. a day, the cost would be 1/6 of a million at $2.84 = $0.47 plus 2/3 of a million at $3.31 = $2.20; a total of 833,000 gal. at a cost of $2.67 or $3.20 per 1,000,000 gal. For various unit costs of pumping corrections may readily be made. For cost of pipe delivered to station within one or two miles of construction work other than $30 per ton, the cost may be closely approximated by varying the cost on the pipe line and the 6 per cent on investment proportionately, as the cost of iron is a large part of the cost and generally when pipe is high labor is also high. Actual cost of pipe line chosen for table may readily be found as 6 per cent of the cost is given.

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*[illegible] 26 before the Illinois section of the American Water Works Association.

Ice in Water Mains in May.—An excellent illustration of the severity of the cold period of 1917-18 in New England is given in the last annual report of the Water Department of New Bedford, Mass. On May 28, when the Department removed a line of 4-in. main for the purpose of replacing it with pipe of larger size an 8-ft. section of the 4-in. pipe was found to be filled solid with ice.

COST OF DELIVERING WATER AT UNIFORM RATES OF FLOW THROUGH PIPE LINES.

	Diameter of pipe														
	6 inches.			8 inches.			10 inches.			12 inches.			14 inches.		
[illegible]	Operation.	6% of pipe line cost.	Total.	Operation.	6% of pipe line cost.	Total.	Operation.	6% of pipe line cost.	Total.	Operation.	6% of pipe line cost.	Total.	Operation.	6% of pipe line cost.	Total.
100,000	$0.42	$6.92	$7.34	$0.11	$9.12	$9.23	.....	.....	.....	.....	.....	.....	.....	.....	.....
150,000	.86	4.62	5.48	.22	6.08	6.30	.....	.....	.....	.....	.....	.....	.....	.....	.....
200,000	1.14	3.46	4.60	.36	4.56	4.92	$0.13	$6.08	$6.21	$0.05	$7.81	$7.86	.....	.....	.....
250,000	2.11	2.77	4.88	.53	3.64	4.17	.18	4.84	5.02	.08	6.25	6.33	.....	.....	.....
300,000	2.90	2.31	5.21	.73	3.03	3.76	.26	4.04	4.30	.11	5.21	5.32	$0.05	$6.21	$6.26
400,000	4.80	1.73	6.53	1.21	2.27	3.48	.42	3.04	3.46	.18	3.90	4.08	.09	4.66	4.75
500,000	6.71	1.39	8.10	1.78	1.82	3.60	.62	2.42	2.84	.27	3.12	3.39	.13	3.72	3.85
600,000	9.77	1.15	10.92	2.46	1.52	3.98	.86	2.02	2.88	.36	2.60	2.96	.18	3.11	3.29
800,000	16.15	.86	17.01	4.06	1.13	5.19	1.42	1.52	2.94	.60	1.95	2.55	.29	2.33	2.62
1,000,000				6.00	.91	6.91	2.10	1.21	3.31	.89	1.56	2.45	.43	1.87	2.30
1,200,000				8.26	.76	9.02	2.89	1.01	3.90	1.23	1.30	2.53	.59	1.55	2.14
1,400,000				.....	.....	.....	3.78	.87	4.65	1.61	1.11	2.72	.78	1.33	2.11
1,600,000				.....	.....	.....	4.77	.76	5.53	2.04	.97	3.01	.98	1.16	2.14
2,000,000				.....	.....	.....				3.01	.78	3.79	1.45	.91	2.32
2,400,000				.....	.....	.....				4.13	.65	4.78	1.99	.77	2.76
2,800,000				.....	.....	.....	.....	.....	.....	.....	.....	.....	2.60	.66	3.26
3,200,000				.....	.....	.....							3.29	.58	3.87
3,600,000				.....	.....	.....							4.03	.52	4.55

	Diameter of pipe											
	16 inches.			20 inches.			24 inches.			30 inches.		
[illegible]	$0.07	$4.50	$4.57	.....	.....	.....	.....	.....	.....	.....	.....	.....
[illegible]	.09	3.75	3.84				.....	.....	.....	.....	.....	.....
[illegible]	.15	2.81	2.96	$0.05	$3.90	$3.95	.....	.....	.....	.....	.....	.....
[illegible]	.23	2.25	2.48	.08	3.12	3.20	.....	.....	.....	.....	.....	.....
[illegible]	.31	1.88	2.19	.11	2.60	2.71	$0.04	$3.39	$3.43	.....	.....	.....
[illegible]	.41	1.61	2.02	.14	2.23	2.37	.05	2.90	2.96	.....	.....	.....
[illegible]	.52	1.40	1.92	.18	1.95	2.13	.08	2.54	2.62	.....	.....	.....
[illegible]	.76	1.13	1.88	.25	1.56	1.81	.11	2.04	2.15	$0.04	$2.93	$2.97
2,400,000	1.05	.94	1.99	.36	1.30	1.66	.15	1.70	1.85	.05	2.44	2.49
[illegible]	1.37	.80	2.17	.48	1.11	1.59	.20	1.45	1.65	.07	2.09	2.16
3,200,000	1.74	.70	2.44	.60	.98	1.58	.25	1.27	1.52	.09	1.83	1.92
[illegible]	2.13	.63	2.76	.74	.87	1.61	.31	1.13	1.44	.11	1.63	1.74
[illegible]	2.56	.56	3.12	.89	.78	1.67	.37	1.02	1.39	.13	1.46	1.59
[illegible]	3.80	.45	4.25	1.32	.62	1.94	.55	.82	1.37	.19	1.17	1.36
[illegible]	.....	.....	.....	1.81	.52	2.33	.76	.68	1.44	.26	.98	1.24
8,000,000	.....	.....	.....	3.00	.39	3.39	1.25	.51	1.76	.43	.73	1.16
[illegible]	.....	.....	.....	.....	.....	.....	1.86	.41	2.27	.63	.58	1.21
[illegible]	.....	.....	.....	.....	.....	.....	2.56	.34	2.90	.87	.49	1.36
[illegible]	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.15	.42	1.56
[illegible]	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.45	.37	1.82

POWER AND PUMPING SECTION

This section of the Waterworks and Hydraulic Monthly issue of Engineering and Contracting is devoted to the selection of power and pumping equipment and the economic management of its operation.

Principles of Boiler Water Treatment

As a means of encouraging further economy in the use of fuel the United States Fuel Administration has issued a bulletin on the subject of scale forming materials in boiler water and the most readily available means for counteracting their effects. The notes following are taken from the bulletin.

A source of unnecessary waste of fuel originates in the use in boilers of so-called "hard" water. This leads to the deposition upon the boiler metal of insulating material contained in the water which retards the flow of heat from the furnace to the water to such an extent that the amount of heat escaping through the stack is materially increased. A steam pipe covered with asbestos, magnesia or other heat-insulating material keeps the heat in the steam. A boiler tube coated with scale or other heat-insulating material, keeps the heat out of the boiler water, and sends it to the stack. By lagging pipes fuel is easily saved. By lining tubes with scale it is wasted continuously and needlessly.

The Nature and Origin of Scale Forming Material.—All natural waters contain more or less heat-insulating material, partly as suspended matter (such as clay, fine sand, insoluble forms of iron, aluminum, etc.), partly as dissolved matter, such as compounds of calcium, magnesium, sodium, potassium and other mineral salts. Much of the suspended matter, as well as most of the dissolved matter, may form scale. The suspended matter may generally be removed by filtration.

Of the material commonly in solution in boiler waters, the bicarbonates and sulphates of calcium and magnesium are the most important scale formers. Natural waters containing in solution bicarbonate of calcium or magnesium, or both, exhibit what is called "temporary" or "carbonate" hardness; those containing dissolved calcium or magnesium sulphate or both possess "permanent" or "sulphate" hardness. In the case of the sulphate scale the temperature required to separate it is too high to make its removal by heating alone a practical means of treatment. In the case of water exhibiting carbonate or temporary hardness great improvement in its properties may be effected by the use of open heaters of the exhaust steam type. As a rule sulphate scale is denser in structure with a higher heat-insulating value than carbonate scale, but the conditions of formation affect this considerably. Where a porous structure permits water to penetrate the scale its heat-insulating effect is greatly reduced.

The Effect of Scale.—In many respects the effect of an increasing deposit of scale on the passage of heat through the walls of a boiler tube is very similar to the effect on the passage of water through a tube of continually decreasing bore. In the case of the water tube, the only way to get a uniform volume of water through it in a given time, in spite of its diminishing bore, is continually to increase the pressure in the water; so in the case of a boiler tube covered with a dense scale the only way to maintain a constant flow of heat from the furnace to the boiler water is to increase the "heat pressure," so to speak; that is, to burn more fuel.

Heat Loss.—The most important effect of scale is due to the fact that in certain forms it is a wonderful heat insulator. Its chemical composition seems to have little to do with its heat-insulating power, the big question being the density or mechanical structure of the scale. A series of experiments by Prof. Schmidt, of the University of Illinois, gave the following results, showing decrease in heat-transfer efficiency of tubes coated with scale of different thickness and composition:

Character of scale	Thickness Inch	Composition	Loss of efficiency Per cent
Hard	1/50	Mostly carbonate	6
Soft	1/32	Mostly carbonate	7
Hard	1/32	Mostly carbonate	8
Soft	1/25	Mostly carbonate	8
Hard	1/25	Mostly sulphate	[illegible]
Do	1/20	Mostly sulphate	11
Soft	1/16	Mostly sulphate	10
Do	1/16	Mostly carbonate	11
Do	1/16	Mostly carbonate	12
Hard	1/16	Mostly carbonate	12
Soft	1/11	Mostly carbonate	15
Hard	1/9	Mostly sulphate	16

This expressed in dollars and cents means that with a deposit of 1/9 in. of scale, 16 ct. of every dollar paid for coal is lost.

The data just given must not be regarded, however, as indicating that the decrease in the heat-carrying capacity of scale covered tubes can always be calculated with the accuracy that these figures would indicate. The important facts are, though, that the loss is easily prevented and that the advantages of soft water abundantly justify all expenditure necessary to secure it.

Just what the loss is in any particular case could best be determined by comparing the fuel consumption with clean and then with scale-covered tubes, other operating conditions being kept uniform.

Means of Removing Scale Forming Elements.—The methods employed in softening water may be divided into two main classes, (a) those in which the scale-forming property is removed before the water enters the boiler, (b) those in which the softening is effected within the boiler itself by means of so-called "boiler compounds." As to which one of the two classes of methods should be employed in any particular case would depend on the size of the plant, and on the character of the water to be softened. In the case of waters of abnormal composition, it would frequently be impossible to produce a satisfactory water by either method and a new water supply would be necessary.

It can not be too strongly emphasized that this question of water treatment is one in which the employment of competent chemical and engineering knowledge is both absolutely necessary and highly profitable, and it would be far wiser to omit all forms of water treatment (involving the use of chemicals) rather than to undertake such without knowing accurately the composition of the water and of the material used to soften it. It is most important to remember that the quality of the water, even when secured from the same source, varies widely from time to time. These variations are not only seasonal and monthly, but daily and even hourly. A condition of excessive concentration of the water after a protracted drought may be changed within an hour to a correspondingly excessive dilution by a summer storm. The result would be to decrease enormously the percentage of dissolved matter and to increase probably to a much greater degree, the amount of suspended matter.

As a consequence, a prescribed treatment of the water based on its analysis at any particular time might not lead to satisfactory results if applied at some other period.

As an instance of the serious danger of an unintelligent "dosing" of boiler waters may be cited the results of a long series of investigations which have, apparently, shown that carbonate of soda in solution produces brittleness in boiler steel. Carbonate of soda (soda ash) is used in most water-treating processes and its unintelligent use may readily lead to a very dangerous condition in a boiler.

Boiler Compounds.—Boiler compounds afford a very useful means of boiler-water treatment in plants whose size or value of output would not justify the use of a more expensive method. This would be true of a large percentage of the plants of the country.

[illegible] of a great variety of trade names a very large percentage of all boiler compounds consist most largely of [illegible] soda, to which [illegible] is sometimes added, and occasionally phosphate of soda. Starchy materials and [illegible] are frequent ingredients. The supposed effect of these last two materials is to coat the particles of precipitated incrusting material and prevent its cohesion into compact scale.

[illegible] that they are used in moderation, is the necessity of frequently blowing down the water to prevent the accumulation of "sludge" and of alkaline [illegible] in the water, both of which cause foaming. Furthermore, this blowing down must be supplemented by [illegible] and occasionally cleaning down the boiler to complete the removal of the sludge and of the boiler compound itself. Whenever competent supervision of boiler water treatment is available within the plant organization, it is preferable to soften the water before it enters the boiler, and this must be done when the percentage of scale forming ingredients is high.

Treating the Water Before It Enters the Boiler.—The removal of scale forming components from water by chemical means, whether before or after entering the boiler, is accomplished by converting the calcium and magnesium compounds into practically insoluble forms, causing them to separate from the water and allowing the material to be removed by blowing down filtering, or sometimes by settling. Lime and soda ash are generally used for this purpose when the softening occurs before the water enters the boiler. The lime combines with the carbon dioxide which held the calcium and magnesium carbonates in solution; these are no longer soluble in the water after removing the carbon dioxide, and therefore, separate from it. In a similar way the sulphate scale is removed by its conversion to insoluble carbonate by the soda ash.

The Lime-Soda Process.—There are in current use in power plants practically only one lime-soda process, of which there are two varieties differing chiefly in the temperature of the water when treated. In all essential respects the two varieties are similar. The treatment consists of adding to the "raw" water softening agents in carefully controlled amount (which must agree with the composition of the water), mixing these thoroughly within the water, and permitting sufficient time to elapse for the separation of the "sludge" before the water is fed to the boiler.

In the case of the "hot-continuous" process this separation is effected more rapidly, which permits of less storage capacity than in the case of the "cold continuous." In all cases, though, it is of the utmost importance to provide sufficient storage space to allow the sludge to be completely deposited before the water is fed to the boiler; otherwise the partially completed softening process will be completed within the heater, and the purpose of the treatment will be largely defeated. Another advantage of the hot process is that it expels the air from the water and so reduces the corrosion.

The Zeolite Process.—This is entirely unlike the processes described above and (unlike them) gives a water of zero hardness. The softening agent is an artificial material composed largely of sodium compounds, which are exchanged for the incrusting (scale forming) material of the water; that is, the water dissolves sodium compounds from the softener and replaces it by the calcium and magnesium which had caused the hardness of the water. The hard water simply flows over the "permutit" packed in a cylinder or is forced up through it and flows from it with all scale-forming material removed. After a time the softener must be regenerated by allowing a solution of salt to flow over it, restoring its original composition and activity. The "permutit" process is a well known efficient variety of the zeolite treatment.

The construction and operation of this softening equipment is extremely simple, and, as already stated, water of zero hardness is furnished. On the other hand, in the case of water of a high degree of temporary or carbonate hardness there is a correspondingly large amount of sodium salts introduced into the water, so that foaming is liable to occur (as is liable to occur when softening water of a similar composition by means of boiler compounds). In such cases the following modified form of the Zeolite process is used.

The Lime Zeolite Process.—In this an intermittent or continuous tank equipment, as described already under the lime-soda process, is connected through a filter to a zeolite softener. Only lime is used in the tank, the soda compound being secured from the zeolite. The filter is placed between the tank and the zeolite softener to avoid any sludge coating the permutit particles and so impairing its efficiency.

Filters.—No process of water softening is satisfactory unless the amount of suspended matter is reduced to a minimum. In the case of very finely divided matter this may be done by adding so-called coagulants—alum, for example—but these should be used with extreme caution and always under expert direction. Ordinarily, though, such suspended matter is removed by filters, of which the sand filter with a down flow of the water is the most satisfactory type. They are not expensive, either in original or maintenance costs.

Removing Scale Already Formed.—The purpose of the methods described above is to prevent the formation of scale. There is another class of water-treating material used largely to remove scale already formed and to some extent prevent the formation of new scale. Graphite and kerosene are most often used for these purposes. Their action seems entirely mechanical. Opinions as to the desirability of their use vary from enthusiastic commendation to absolute condemnation, though their use seems generally approved by practical men. Neither should be used, however, in boilers in which there is already a heavy deposit of scale, as the loosening of this and its accumulation in the bottom of the boiler is apt to lead to blistered and bagged boiler metal. Both graphite and kerosene should be used very cautiously. Kerosene, if used in excessive quantity, is apt to distill over and attack gaskets.

Economies Effected by Softening Water.—There is a very direct relation between softening water and saving fuel; the following are a few cases reported of such economies:

A crucible steel company, by substituting soft for hard water, effected a saving of 3,600 tons of coal per annum, which based on current prices would be valued at about $22,000.

The Chicago & Northwestern Ry., comparing its operating expenses in 1902-3 before and after softening its water supply, effected a saving of $75,000 per annum. This saving was made at a period when coal cost probably less than one-half the prices charged at the present time.

In addition to these, other cases have been reported in which the profits resulting directly from the substitution of soft for hard water have been reported as varying from 32 per cent on an investment of $7,200, to 71 per cent on an investment of $7,000. These profits resulted largely from the elimination or reduction of operating costs, such as cleaning heaters, piping, and economizers, cost of cleaning instruments, interest, and depreciation on spare or idle boiler, etc.

Furthermore, it has been estimated that the use of hard water in a great number of the locomotive boilers of the country involves the consumption of 15,000,000 tons of coal more than would be needed were soft water only used.

A steel company whose annual output is 50,000 tons, reports a saving of 200 lb. of coal per ton of steel resulting from the softening of its boiler water.

The above are convincing evidences of the opportunity presented to power plant operators for saving by means of water softening, a very considerable proportion of the coal which will be mined during the current year. The United States Fuel Administration feels that it can count very confidently on the adoption by all power-plant operators of this simple and effective means of fuel economy which is of such especially vital concern at the present time.

Cold Weather Precautions at Brookline, Mass.—During the coldest weather of 1917-1918, the Water Department of Brookline, Mass., flushed many of the hydrants on the dead ends. The flushing was done every two or three days to keep up the circulation of the water in those mains, as the frozen ground in many streets extended down to the pipes. The last annual report of the department states that some of the mains in thinly settled parts of the town would certainly have frozen if this precaution had not been taken. The practice of using a short piece of lead pipe at the junction of the service pipes with the mains, and thus dropping the service immediately 6 in. also saved many service pipes from freezing. No hydrant was permanently frozen, but the posts of 11 of these were broken evidently by the upward movement of the ground in freezing—a trouble never before experienced—although all hydrants were provided with frost jackets. No mains were frozen, and only eight service pipes. The frost penetrated the ground to a depth of 5 ft. and over.

New Pumping Units for Lynn Water Supply

By REEVES J. NEWSOM.

Commissioner of Water Supply.

A contract was awarded a few months ago by the Department of Water Supply of Lynn, Mass., for two motor driven centrifugal pumping installations that have a number of interesting features. One of the units will have a capacity of 16.4 million gallons per day; the other will have a capacity of 20 million gallons per day.

One unit will be installed in the Glen Lewis Station to pump water from Walden Pond Reservoir to Breeds Pond Reservoir, and will replace a motor-operated centrifugal unit which was installed in 1912 and which is badly suited to its conditions and very much out of date in its design. This unit pumps 14.3 million gallons per day against a 20-ft. head at an efficiency of only 42 per cent and requires 90 kw. to drive it. The new unit is guaranteed to pump 16.4 million gallons per day against a 20-ft. head at an efficiency of 72 per cent and will require 60 kw. to drive it. This new unit will cut the cost of pumping from $2.70 per million to $1.60 per million, a saving of $1.10 per million or $3,300 for the average year's pumping of 3,000 million gallons. The investment in this installation will be about $10,000.

The other unit is to be placed in a new pumping station between Hawkes Pond Reservoir and Walden Pond Reservoir, which installation will take the place of the Walden Pond Station, a steam station built in 1902. As a result of the new location of the proposed station the connection between the reservoirs will be entirely by pipe line and a long canal on the suction side of the old pump will be eliminated. This will cut the head from 45 ft. to 27 ft. and this fact, together with the reduction of labor to operate the pumps and screens from 12 men in 24 hours to one man who is also a patrolman on the reservoir, will effect a great saving in operation costs. The Walden Pond Station pumps 22 million gallons per day at a cost of $120 or $5.45 per million. The new unit will pump 20 million gallons per day against a 27-ft. head at an efficiency of 74 per cent, requiring 96 kw. to drive it. This is at the rate of $2.07 per million, a saving of $3.38 per million or $8,800 for the average year's pumping of 2,600 million gallons. The cost of this installation, including pumps, station and pipe line, will be about $40,000 with a credit of about $15,000 from the sale of the station and equipment to be abandoned.

The net amount invested in these two installations will be $35,000 and interest at 4 per cent is $1,400 per year. The saving in operating costs will be $12,100 per year or a net gain of $10,700 per year, which is a return of about 30 per cent on the investment.

The selection of the size of pumps and the decision as to the average head against which they were to be designed to operate was made by the writer only after a careful study of the conditions which might be expected in the next 10 years. As a basis for the study, 40 years' records of runoff of the Sudbury River were converted and applied to the catchment areas of the reservoirs, the Saugus River which flows into Hawkes Pond Reservoir by gravity, and the Ipswich River, water from which is pumped into Walden Pond Reservoir through a 36 in. cast iron pipe line 6 miles in length, by a motor-operated centrifugal pump in our Ipswich River Station of 15 million gallons per day capacity.

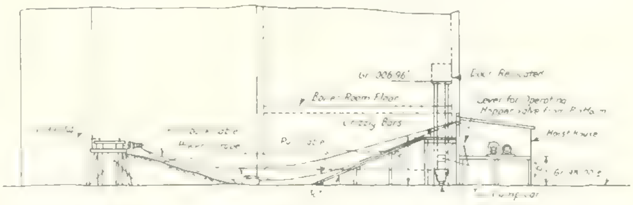
Using these computed runoff records, and taking into consideration the proper handling of our reservoirs to derive the maximum benefit from their storage capacity, the probable increase in the consumption of water in the next 10 years, the comparative costs of pumping with different sized units through different sized pipe lines and from different station locations, the writer determined upon the proper size of the proposed pumps and a scheme for the handling of the two rivers, the three reservoirs, and the three pumping stations, which is economical and efficient as regards purification. This method of handling the water was then combined with the runoff records for the 40 years. The elevations of the ponds were computed for the first of each month for the entire period, and by comparing the heights of the water in the various ponds, the heads against which the pumps will operate were computed for each month.

From these data there was determined the probable average conditions under which the pumps will operate and the limits of the variation of head. The specifications for pumps included a diagram giving the range of the static head conditions superimposed on the friction curve of the pipe lines with four subdivisions of this variation and the percentage of water to be pumped within each subdivision.

The contract for the pumping units was awarded to the Power Equipment Co., Boston, Mass., which will supply De Laval Steam Turbine Co. pumps and General Electric Co. motors.

Handling Coal for Power Plant With Bottomless Power Scrapers

Bottomless power scrapers are employed by the Pittsfield Electric Co., of Pittsfield, Mass., in handling coal for its power house. The arrangement is shown in the accompanying sketch. The scraper is used to reclaim coal from any part of the coal trestle by being pulled up a semi-circular incline to a hopper. This hopper is fitted with a gate and loads a ½ ton industrial dump car which is pulled up onto a trestle in the boiler house by means of a single drum hoist.

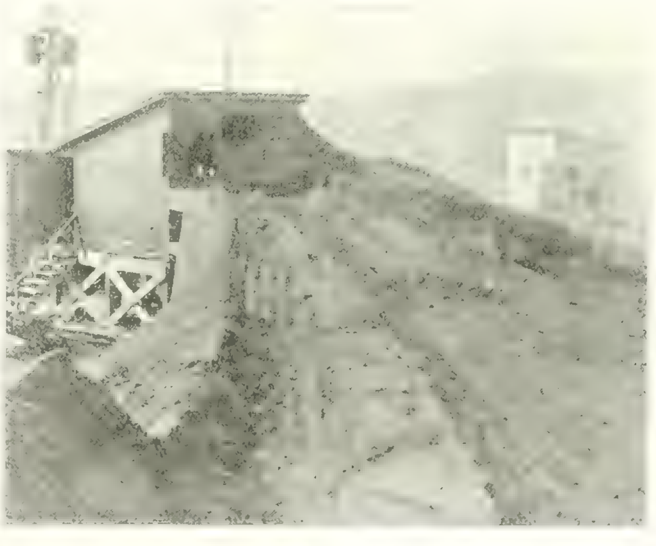


Arrangement for Reclaiming Coal with Scraper Outfit.

The 1/3 cu. yd. scraper of the Sauerman bottomless type is operated by a double drum Mead-Morrison hoist and 25 h. p. motor and supplies sufficient coal to keep the industrial car amply supplied and moving at the rate of 17 tons per hour delivered in the boiler room.

During last fall when the coal shipments were irregular and a large stock was needed an additional bottomless scraper was put at work. This scraper was of ½ cu. yd. capacity and was operated by a double drum hoist housed in a separate shed. It was used to handle coal from the trestle into a stock pile during the time when shipments came in rapidly.

The coal trestle is only 12 ft. high, but by means of the scraper the company placed over 10,000 tons in its stock pile by scraping coal away from the trestle, a distance limited only by the length of cable. In this work the pull back cable is merely hooked onto the trestle at any point by means of a snatch block.



Scraper Approaching Top of Incline with Its Load of Coal, Which Will Be Automatically Dumped into the Hopper Located Just Front of Hoist Shed.

Mr. W. A. Whittlesey, Superintendent of the Electric Company, states that they have not had a fire in their coal pile since the scrapers were installed, this being due principally to the fact that a low height of pile is possible and also because it is very easy to scrape the stock pile at any point that seems warm.

59 Engine Room Pointers

[illegible] power plant engineering. [illegible] from the [illegible]

(1) If a rusty piston rod [illegible] from the crosshead [illegible] with a Stillson wrench, [illegible] two hardwood [illegible] to it by means of [illegible]. A piece of [illegible] should be placed [illegible] the rod and the blocks which, when clamped to the [illegible]. The blocks afford a place to put a wrench and turn the rod out of the crosshead.

(2) When the packing sticks in the stuffing box of an engine, [illegible] the engine on the crank end [illegible], which will blow the packing out [illegible]

(3) [illegible] engine is frequently caused by the vibration of the [illegible] have a little too much play between the bull rings. The trouble can partly, if not [illegible] a set of stiffer piston ring [illegible]

(4) Adjust the catch plates on a Corliss engine so as to give them sufficient surface on their working edges, and they will wear longer. Also see that the working edges strike each other squarely. If the springs are weak, strengthen them [illegible] toward each other in a [illegible] set of springs.

(5) In changing the speed of a Corliss engine the governor should be pulleyed so that it will run at the old speed—the speed for which it was intended. A little departure from this speed will keep it against one or the other of its stops.

(6) An engine runs forward or over when, standing at the [illegible] the wheel revolves [illegible] from you.

(7) Babbitt metal should not be used over and over again for the reason that every time babbitt metal is melted some of the tin and antimony is burned out. The scum that appears on the top of the metal when it is heated is an oxide formed by the combination of the metal with oxygen from the air.

(8) [illegible] larger at the crank end to overcome the resistance due to friction, which acts with a greater leverage on the crankpin than on the crosshead pin, the latter being smaller in diameter than the former. The stresses due to the inertia of the rod also call for a larger section of the rod at the crankpin end than at the crosshead pin.

(9) The addition of lap will generally prevent the steam valve from opening sufficiently for the proper admission of steam, hence when the lap is increased it becomes necessary to increase the travel in order to provide the proper port opening. An increased travel of the valve also opens the port more rapidly, which is an important consideration.

(10) A crankpin will heat if it is not large enough to do the work, if good lubrication is not provided, if dirt gets inside the brasses, if the brasses are not properly fitted, or if the brasses or pin are not of good material and in a smooth condition. Being out of line or keyed too tightly also causes it to heat.

(11) The length of a connecting rod depends much on the design and duty of the engine. For large stationary engines the length of the rod is 2½ to 3 times the stroke of the piston, if space permits; on smaller engines the ratio is sometimes reduced.

(12) Upon taking charge of a new plant, do not begin by making promiscuous adjustments. It is better to wait a day or two until the apparatus is thoroughly understood, and then changes should be made only after the object to be attained is definitely known.

(13) In condensing it is usual to use about 27 to 30 times as much injection water (by weight) as the steam to be condensed; the temperature of the hot water should not be above 120 deg.

(14) Burnt oil may be cleaned from the cylinder head of an engine by using strong lye-water, and after it if cleaned paraffin rubbed over the surface will keep it bright.

(15) In packing a flange or cylinder with a rubber gasket, all oil and grease should be wiped from the surface of the metal.

(16) A self-contained engine is dependent upon its own frame to hold all of its parts together.

(17) A right-hand engine is one the flywheel of which is to the right when looked at from the cylinder.

(18) The advantage of running an engine over is that the pressure of the crosshead is always downward upon the guide. If the engine is run under, the thrust of the crosshead would be upon the top guide on both the outward and inward strokes, and unless the crosshead is properly adjusted, it will lift when subjected to thrust and fall by its own weight on the center, making the engine pound.

(19) An automatic cut-off engine regulates its speed by cutting off the steam supply according to the load, thus using a greater degree of expansion than when as in the throttling engine, the cut-off is late enough to carry the maximum load. The slide-valve throttling engine regulates its speed by throttling the steam between the boiler and the cylinder.

(20) The cut-off valve on the low-pressure cylinder is used for adjusting and equalizing the work performed by the steam in the high and low-pressure cylinders.

(21) If an engine is pounding, in searching for the cause of the trouble do not attempt to remedy it too soon. If it is apparent that keying-up is required, do not key too tightly and try to do it all at once, as the crankpin or crankshaft may be flat on one side and there is danger of getting a hot bearing or brasses.

(22) If the governor belt should break, will your engine stop? If you do not know this to be the case, see to the adjustment of the safety cams on the Corliss engine and to the automatic stops on other types of engines, and make sure that they are adjusted to operate. They are likely to get out of their proper position and should be examined at least once a week, and tested to see if they will control the engine.

(23) When the length of a connecting rod is reduced by constant keying-up, it results in the piston traveling much nearer to the front cylinder head. To prevent this shims are used back of the brass, next to the end of the rod. In some types of connecting rods the distance between the crankpin and the wristpin centers is lengthened by keying-up, and the shims should be placed between the brass farthest from the rod; that is, between the brass and strap.

(24) An ordinary cross-compound engine can be started without prying on the flywheel by admitting steam to the low-pressure piston by means of the by-pass valve on the receiver, in case the high-pressure crank is on the center.

(25) If the striking points of the piston against the cylinder head are not known, marks should be placed on the guide so that it can be clearly seen at any time that the piston has sufficient clearance at the end of the stroke, which should be kept equal at each end.

(26) The thinner the packing between a cylinder head and the cylinder, the better. Thick packing is more likely to blow out, and the additional thickness unnecessarily increases the clearance in the cylinder.

(27) In packing valve stems or piston rods, never use old packing that has been removed. It has lost its elasticity, and there is danger of its scoring the rods.

(28) Frequently the sight-feed glass of a lubricator fills with oil. If the oil is removed from the body of the cup and it is filled with water and started up in the usual way, the water will float the oil out of the glass without further trouble.

(29) In placing rubber packing joints together, use either graphite or chalk to prevent the rubber adhering to the metal when the joint is to be broken.

(30) After making repairs on a pipe line connecting with an engine, it should be blown out, the steam being allowed to flow into the steam chest, the ports of which have been either plugged or covered by the valve.

(31) Follower bolts lose their strength by crystallization, caused by alternate cooling and heating, and are likely to fracture when comparatively small strains are brought to bear. To be on the safe side careful engineers make a practice of renewing these bolts at certain intervals.

(32) The dashpot of a Corliss engine should have a plentiful supply of machine oil or oil of a heavy grade, or else glycerin. The temperature of the engine room will dictate to some extent the heaviness of the oil.

(33) If it is suspected that an engine piston is leaking steam, place the engine on the crank-end dead-center, and after removing the cylinder head, on the head end, admit steam back of the piston. Any leak can be readily detected.

(34) Another method of detecting piston leaks is to place the engine on either center and open the indicator cock from

the opposite end from which the steam is being admitted. In this test, however, the steam valves must be tight.

(35) To keep in touch with the operation of the plant to determine if it is working at the highest efficiency, it is necessary that a correct log be kept of all departments. This log of itself has no value unless it is carefully analyzed from day to day to determine whether the plant did maintain the highest efficiency on each particular day under the conditions at which it was necessary to operate.

(36) A cylinder oil containing acid will probably cause pitting of the cylinder walls, hence it is advisable to watch the condition of the cylinders after changing from an oil that is known to give good satisfaction to another grade.

(37) In changing the speed of an engine, care should be taken to adjust the governer springs so that the sounds, when they are tapped with a hammer, will be as nearly alike as it is possible to get them. If the sounds are different it is a case of unequal tension, which will result in unequal strain and may cause racing.

(38) Drains for steam pipes should be provided at all points where it is possible for water to accumulate. Some may be for use only when putting the line into service, but are necessary at such times. Drains from points where there is even slight difference in pressure should not be joined together or to the same trap, as the difference will prevent the proper operation of the one of lower pressure. If a still lower pressure or constant discharge is maintained beyond the point of junction, as in the Holley loop, the foregoing does not apply.

(39) Mechanical efficiency is a term intended to express the ratio of indicated horsepower to that available for doing work. Brake horsepower divided by indicated horsepower gives the mechanical efficiency. For small single-cylinder engines the mechanical efficiency may be as high as 94 per cent, or the friction 6 per cent of the indicated power. For large compound engines the mechanical efficiency is sometimes as low as 80 per cent, or the friction 20 per cent of the indicated power.

(40) Cement of specially valuable properties for steam pipes and for filling up small leaks such as blow-holes in a casting, without the necessity of removing the injured pieces, is composed of 5 lb. paris white, 5 lb. yellow ochre, 10 lb. litharge, 5 lb. red lead, and 4 lb. black oxide manganese, these various materials being mixed with great thoroughness, a small quantity of asbestos and boiled oil being afterward added. The composition, as thus prepared, will set hard in from two to five hours and possesses the advantage of not being subject to expansion and contraction to such an extent as to cause leakage afterward, and its efficiency in places difficult of access is of special importance.

(41) The turbine can be designed to operate on very low terminal pressures with comparatively slight increase of cost; its action as a heat machine is such that a greater expansion can be utilized and the economy is greatly improved by any increase in vacuum. When run noncondensing the turbine is less economical than the noncondensing engine.

(42) One of the large heat losses incurred in the steam engine is that due to cylinder condensation, and one of the common methods of reducing it is to limit the range of temperature through which the steam is allowed to work in a single cylinder. For this reason simple engines are better adapted for low steam pressures while compound- and triple-expansion engines are advisable for high-pressure and high-temperature ranges, particularly if the load is uniform.

(43) After removing loose dirt with a stiff brush, files can be cleaned of grease by boiling them for about 45 min. in a solution consisting of ¼ lb. of saleratus to a quart of water. The files are then thoroughly washed in clean water and dried and placed on end, completely submerged in a solution consisting of ¼ lb. of sulphuric acid to a quart of water. After remaining in the acid solution for about 12 hr. the files should be thoroughly washed in clean water, quickly dried and given a light coating of kerosene or other thin oil to prevent rusting.

(44) The engine as a rule develops mechanical troubles with high superheat, especially where the steam valves have much travel under unbalanced pressures. The consensus of opinion seems to be that for slide- or gridiron-valve gears a temperature of 400 to 425 deg. F. should not be exceeded, while the best point for the Corliss-type engine will be found below 450 deg. F. Above these limits lubrication is unsatisfactory and distortion of the parts is apt to give trouble.

(45) The highly economical steam turbine must necessarily be operated condensing, but there are many cases where high steam economy is not the most important and the noncondensing turbine often finds favor over the steam engine.

(46) The advantages of small, high-velocity steam piping are: Lower first cost for pipe, valves and covering, etc., less erecting and maintenance cost; less weight; less radiation loss; less chance for water to accumulate and less difficulty with valves of smaller size.

(47) In plants where the exhaust is atmospheric and cannot be applied to any useful purpose, the engine best fills the conditions, provided space is available, and the speed may be made low enough to insure smooth, quiet running. Such an application is found in direct-current generator sets of 100 kw. capacity and larger, in hotels, office buildings and hospitals, where the exhaust is used for steam heating in winter and must be wasted for several months in the year.

(48) The horsepower constant is the number of horsepower per pound of mean effective pressure developed by an engine when running at its normal speed. It will be different for different speeds. Knowing the constant, one need only multiply the mean effective pressure (obtained from an indicator diagram) by this constant to know what indicated horsepower the engine is developing. Evidently by the definition, the horsepower constant is all of the "PLAN" formula except the P.

(49) A brass-polishing paste, said to give satisfactory results, is composed of camphor gum, 1 oz.; alcohol, 2 oz.; spirits of ammonia, 2 oz.; spirits of turpentine, 4 oz.; candle paraffin, 1 lb.; clean tallow, 1 lb.; tripoli, 1 lb. For compounding, first dissolve the camphor in the alcohol, then melt down the tallow and paraffin and stir in the liquids and the tripoli. Before cooling, the paste can be packed in boxes of sizes convenient for use.

(50) Endplay of a crankshaft may be caused by the crankpin brasses being out of line and bearing alternately on opposite ends of the crankpin, or to the shaft being out of line, causing a wobbling motion of the flywheel, or, in a single-crank engine, by lost motion in the crankshaft bearings.

(51) Where an engine foundation rests on soil, gravel or loose rock, trouble is likely to arise in preserving the engine-shaft alignment unless the bed and outboard bearing of the engine are supported on a monolithic foundation. For that purpose concrete foundation beds are usually made L-shaped, having the main foundation bed extended under the flywheel pit and the necessary distance beyond it for receiving the pier for the outboard bearing.

(52) Cracks or flaws in a smooth metallic surface are rendered visible by thoroughly moistening the surface with kerosene and then rubbing and drying it with a clean cloth and subsequently rubbing over the surface with chalk. The location of flaws will then be revealed by traces of the kerosene coming out again from the cracks into the chalk surfacing.

(53) Periodical inspections of engine cylinders should be made to ascertain whether the piston has lost its proper alignment by wear or other causes, to determine if the cylinder has been cut, if the follower bolts are secure and free from fracture, and if shoulders have been formed on the ends of the cylinder from improper lining of the connecting-rod.

(54) Steam separators with receivers of liberal proportions should be used near engines, to provide a reservoir of steam near-by and to minimize pulsations in the lines.

(55) Surface condensers are allowed from 1½ to 2½ sq. ft. of tube surface per indicated horsepower, or, better, 1 sq. ft. tube surface for 8 to 12 lb. of steam to be condensed per hour.

(56) Reducing valves that are too large for the amount of steam they are to pass are usually unsatisfactory. Either they will open and close continually and chatter violently, or will stand in a position nearly closed and become steam-cut and leaky. It is more satisfactory to use two small valves in parallel, one set slightly heavier than the other, so that one will supply steam up to its maximum capacity before the other opens. Another way is to use one reducing valve equal to about one-half the maximum demand, and a bypass of about the same capacity with a hand-operated valve in it, so that when the reducing valve reaches its capacity the bypass valve may be opened wide and the reducing valve will close down and simply make up the shortage. This of course requires that an attendant shall observe the pressure gage occasionally.

(57) For running condensing the principal change required

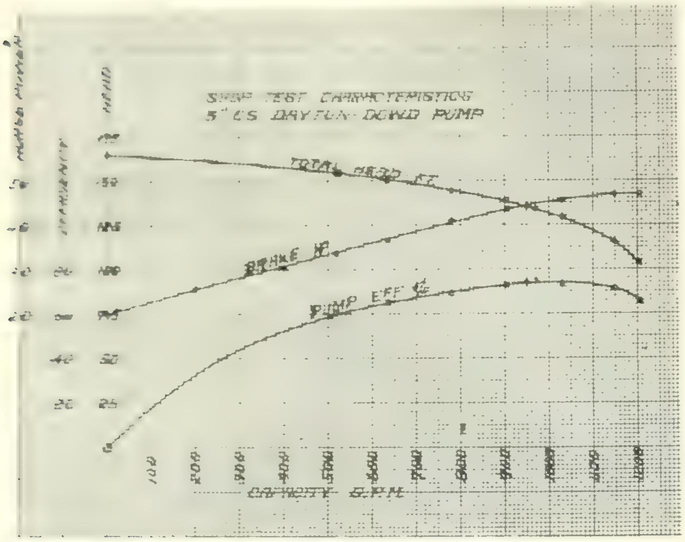
[illegible] earlier closing of the [illegible] of the low-pressure cylinder so as to obtain [illegible] compression of exhaust [illegible].

[illegible] A governor is said to be stable when it assumes a definite position for each particular speed and when a change of speed is necessary for a change of position, while a governor which is in equilibrium at but one speed is said to be isochronous. Perfect isochronism would be impractical as the slightest increase in speed above the normal would result in cutting off the steam, accompanied by a sudden decrease of speed, following which the steam valve would open wide, thus giving rise to extreme fluctuations.

(59) Terminal pressure is the pressure that would be in the cylinder at the end of the stroke of the piston if the [illegible] open until the stroke was completed. On a steam-engine-indicator diagram the terminal pressure may be found by extending the expansion curve to the end of the diagram. The theoretical terminal pressure is found by dividing the pressure at cutoff by the ratio of expansion.

New 5-in. Booster Pumps for Quincy, Ill.

The city of Quincy, Ill., has just put into operation, two 5 in. centrifugal pumps as boosters for the Walton Heights District. The pumps draw from the city reservoir near which they are placed and pump into a tank of 300,000 gal. capacity. When the tank is full the water level is 140 ft. above the reservoir level, and maintains an average pressure of about 50 lb. on the mains in this district.



Shop Test Characteristics of Pump.

The pumps, which were built by the Dayton-Dowd Co., of Quincy, are controlled automatically by Sundh Electric Co. pressure regulators and duplex automatic starting panel so arranged that the pumps will work individually or together. The motors are each 50 h. p. Allis-Chalmers, 440-volt, 25-cycle, 3-phase, 1,440 r.p.m.

It was necessary to load the motor close to rated capacity as the waterworks commission were required by the electric company to keep the power factor above 85 in order to avoid being penalized for current. The power factor of the motor varies as follows: Full load, 91.5; ¾ load, 89.0; ½ load, 83.0.

It was thus necessary to so design the pump that the power would not fall below 35 h. p. during the period of automatic operation.

By referring to the shop test curve shown herewith it will be noted that the unit cannot use less than 40 h. p. nor more than 50 h. p. when working automatically with an elevation difference of 12 ft. This was accomplished by maintaining a high flat pump efficiency curve at the maximum water quantity for a 5 in. pump.

The shop test was verified after installation, the water being measured by a venturi meter, which records a daily charge of pumpage and water consumption.

Twelve Methods That Saved Coal in Cuban Boiler Plant

Owing to the cost of coal rising to three times its pre-war value in a southern Cuban plant, the coal bill became the dominating item in the cost of operating and every economy had to be practiced. All of the hands were either Cuban or Spanish, and at first they were very skeptical as to innovations. However, a study of the operating conditions showed that about 25 tons of coal per day should have been sufficient for the load, the actual consumption being from 30 tons to 35 tons. This was reduced to about 27 tons per day by the following changes:

1. The grate bars of all the boilers were changed so that they had about ⅜-in. clearance between bars instead of ½-in. as before, thus eliminating many holes in the fire due to uneven air supply.
2. The draft was reduced from about 0.70 in. to 0.35 in. by regulating the dampers.
3. All of the settings were calked up with a mixture of fireclay and waste. Between boilers where there was not room for a man to enter iron plates were used to inclose the space and ashes were packed into the tops of the settings to prevent air from entering.
4. The firemen were required to level the fuel beds with a tool made of a 1-in. pipe with a "T" 20 in. long on the end. It was found necessary to plug the handle of this and drill a few holes midway to allow the escape of the hot air inside.
5. The soot was blown off the tubes by hand with a steam lance once in each eight-hour shift.
6. The tubes were cleaned inside, when they were found to have 3/32 in. of scale in the lower tubes.
7. The feed water was raised from 150° F. to about 180° F. by cleaning the heater and piping and changing the suction pipe from 3 in. to 5 in. This was later brought up to above 200° by installing an economizer in the breeching, which had been made large to allow of future increase in capacity.
8. Draft gages were installed on each boiler and a portable gas-analysis set was purchased and a great many tests made to establish the best average draft to use.
9. The thickness of the fuel bed was specified, and the men were taught to estimate it with some accuracy.
10. The ashpits were kept wet and the fires were cleaned once on each shift, especially just before the peak came on.
11. It was required that unnecessary boilers should be shut down promptly and disconnected from the steam lines at once.
12. The condenser of the turbine was cleaned each Monday, each tube being scraped out to insure a maximum of heat transfer, as the circulating water was of tropical temperature during the entire year.
13. Along the bottom of the intake was found a cement-like deposit, several inches thick, which was removed at some expense with small bars and special shovels. It was floated out in small boats about 3 ft. long and a foot or so wide, a little water being left in the pipe for this purpose. This improved the vacuum about ¾ in. The bay was cleaned out near the intake by hand labor so as to allow cooler water to flow into the pipe.
14. Finally, the labor question was solved fairly well by requiring the shift engineers to remain habitually in the boiler-room, superintending the firemen and making periodical visits to the engine room, where the oilers took charge of the operating routine. One extra fireman was put on the peak-load shift and wages were raised from 10 to 15 per cent all around as soon as the saving in coal was definite enough to justify it, after which there was no tendency to object to the methods.

The total saving amounted to about $20,000 per year, states Mr. Henry G. Fenton in the Electrical World, from which this note is taken.

Rainfall at New Bedford, Mass., in 1918 Smallest in 104 Years.—The total rainfall at New Bedford, Mass., in 1918 was 34.21 in., as measured at the gages of the Acushnet Storage Reservoir. This was the lowest of all New Bedford's records, for the past 104 years. The next lowest was 35.89 in. in 1910.

MANAGEMENT AND OFFICE SYSTEM

This section is published twice a month: (1) In the Waterworks and Hydraulic Monthly issue, and (2) in the Railway and Excavation Monthly issue. It covers what may be broadly termed "management engineering" as applied in the civil engineering and construction fields.

A Unique Filing System

A unique system of filing, adapted from the Dewey decimal system, is employed by the Southern Sierras Power Co., of Los Angeles, Calif. While the system was prepared to meet the particular needs of this company the methods nevertheless will be of interest to anyone handling engineering subject matter, from a company library of books and pamphlets to correspondence. The system is described by Mr. C. C. Hogan in the Journal of Electricity. We quote from the article as follows:

Familiar Filing Systems Unsatisfactory.—First, the bulk of the correspondence was between a limited group of people, viz., our officers and directors, department heads and superintendents; with the exception of letters to and from our bankers, government officials and customers (in the aggregate a small percentage of the whole), practically all of our correspondence is inter-office or inter-departmental. Consequently, the ordinary alphabetic system would not suffice. For instance, correspondence with our secretary, Mr. Fisher, if filed alphabetically under "F" would soon accumulate into a mass of miscellaneous and unclassified papers that would render the location of particular documents difficult if not impossible. This objection to the alphabetic systems applies to, I should judge, 90 per cent of our files.

Second, it was not possible to file geographically, that is, by office or stations, for the same reason. If all correspondence with the El Centro office, for example, was filed under El Centro, it would soon resemble a paper factory hit by a German shell.

Third, the use of the ordinary numerical system by which subjects are numbered and indexed in numerical sequence as they arise, while perhaps containing many advantages over the alphabetic or geographic system, nevertheless presented these objections: The duplication of subjects could not be avoided, as the same subjects would be designated by different names, so that the index would not disclose a possible duplication; and, the keeping up of an elaborate index would, in itself, require labor and expertness that could not be expected of the ever-changing force of clerks employed to do this work.

The Dewey Decimal System.—Having eliminated the Alphabetic, Geographic and Numerical-Subject Index system of filing, we did not thereby conjure away the pressing problem before us. Our business was growing, our papers were accumulating and must be classified and filed in some way. After considerable discussion the suggestion floated in from somewhere to try the Dewey decimal system. But while the Dewey decimal system of numbering subjects was the ideal one for subdividing, there was apparently no classification or compilation of subjects which covered our particular line of business. The original Dewey decimal system was applied to library work, and is still the basis of the Standard library classification. The Bell Telephone System also had worked out a telephone subject classification, and a Mr. Williams had compiled a railroad classification on the decimal plan. About the time I tackled the job or shortly thereafter the Journal of Electricity, I believe, published in full a classification designed for the electric light and power business, but a careful study of all classifications then available disclosed the fact that they were either not applicable to our business as a whole, or else were rather loosely thrown together without an orderly and uniform segregation of subjects.

I became thoroughly convinced that the decimal system of numbering was superior to any other arrangement, for two main reasons, i. e., it permitted of designating subjects by definite numbers which could be forever retained in a fixed relation to all other subjects, and it provided a means of unlimited subdivisions without destroying the fixed relation of the primary subjects. It follows that when a subject was once predetermined its name and number would always remain the same, and the repeated use of the subject, name and number would add immensely to its mnemonic value and avoid any possibility of useless duplications.

The problem then was to build up a full-fleshed, red-blooded subject body upon the decimal-numerical skeleton, and this for a time was a poser, for no serious attempt had theretofore been made to designate our correspondence by subjects.

My task was, first, to collect and compile a list of every conceivable subject with which we were likely to deal; second, to group such subjects in uniform and orderly relation to each other.

Collection and Classification of Subjects.—To accomplish the first task, that of collecting subject names, I had access to all the companies' files since we commenced business; current correspondence was carefully analyzed and a circular letter was sent to all department heads and superintendents, requesting them to submit lists of subjects with which they dealt. No attempt was made to suggest names for their subjects, as it was thought that whatever names they might hit upon would perhaps indicate the terms more commonly used. About six months was required to collect, analyze and list the subjects. This called for careful work to avoid duplications and to determine upon subject names that would correspond to subject-matter.

After the list of subjects was compiled in this manner, the second task, that of segregation, was undertaken, and of the two, this was by far the most important. It is easy enough to scramble eggs, but not so easy to reverse the operation. The difficulty of arranging an orderly segregation of the subjects is illustrated by the fact that our present classification is the result of four revisions in the arrangement of primary subjects.

First, I wanted the complete classification to be a reflection of our business, so that by reference to it we would there find reproduced by appropriate name, every act or thing which goes to make up our system and business. I pondered upon this deep and long, for to make my automaton function and serve—to make the classification workable and useful, was a "consummation devoutly to be wished." In arranging the position of my subjects, it occurred to me to follow in logical sequence our own business growth. If the classification was to be a true, undistorted reflection of our business, why not begin at the beginning, that is, the organization and incorporation of our companies, and then arrange the subjects representing our various stages of development in their logical sequence?

This, in short, is the groundwork plan of the classification, for eliminating the "General" division, the main divisions follow our development in regular sequence, Administration (including organization-incorporation), Engineering (construction), Operating, Finance and Accounts, Properties, Public Service. It is intended to comprehend every activity connected with our business from the time it is organized until it is a "going concern." Between those two extremes is found a suitable place for every subject which may arise.

Novel Features of the System.—An original feature of our system, to be found, I believe, in no other classification, is that a definite function or scope is assigned to each division. Administration, as the word itself signifies, comprehends in addition to organization, all managerial functions—the division and exercise of authority from the stockholders down to the humblest employes.

Likewise, the next division—Engineering, embraces definite functions—surveying, construction, maintenance, dismantling.

So on, down through the remaining divisions, definite duties are assigned to each. These are readily distinguishable in practice, and easily memorized so that in filing or locating [illegible] by a most natural process of elimination the segment properly arranged itself in its proper division.

The advantages of this arrangement are very pronounced in practice, yet difficult to put into words. The subject matter appearing in the divisions of Engineering, Operating and Properties, clearly are the nouns [illegible] of things, or terms [illegible] assigned to the divisions [illegible] what is done with the nouns [illegible]. The effect of this is that in placing a subject in either division it becomes [illegible] with the [illegible] of that division. In other words, the particular activity concerning the subject is indicated. For instance, the subject of water wheels, if 331.310 in Engineering division would mean that anything concerning the construction, repair or dismantling of a water wheel would be so numbered. If in 331.310, Operating division, it would concern the operation of the apparatus. If in 531.310, it would concern the purchase, rental or sale of a water wheel. By this automatic combination of nouns and verbs we avoid unnecessary duplication of subjects. In the instance cited, under the ordinary method a separate subject would have to be given:

Construction of Water Wheels.
Repairs to Water Wheels.
Dismantling of Water Wheels.
Operation of Water Wheels.
Purchase of Water Wheels.
Rental of Water Wheels.
Sale of Water Wheels.

At least seven separate subjects, whereas our plan requires but three.

The Principle of Subdivision.—It was then in order to fill in the intervening spaces—to give substance and contour to the body that it may be both pleasing to the eye and useful in service. To build up a classification from the materials at hand that would comprehend every class of business involved and every phase of each class.

It will be noticed that the seven main divisions were assigned the hundred series. The next subdivision is, of course, the tens. With few exceptions, which it is unnecessary to here explain, each of the tens was assigned a class or kind of business in which we are engaged, such as 30. Electric, 40. Railway, 50. Gas, 70. Heating, 80. Water.

Another unique and original feature of the classification is the uniformity observed in assigning identical sub-numbers to the different classes of business in each of the main divisions. This is a great aid to memory, for once the sub-number is memorized, you can confidently locate it in any appropriate main division by using the proper "Hundred." The subject "Substations" (37.) is 237, in Engineering, 337, in Operating, 537, in Properties. This uniformity in numbering is maintained throughout the entire classification, and has proven to be an invaluable aid in actual practice.

Having segregated our business, first, into seven main divisions or groups, second, into the various classes of business, it remained to then combine within each class all the subjects pertaining thereto. Each class, except in general matters affecting all alike, stands on its own bottom and is complete in itself. Each organ of our imaginary man performs its proper function and occupies its predetermined place.

It is unnecessary to go further in explanation of the subject grouping, for it will be obvious, having followed me thus far, that minor subjects pertaining to each class are simply subdivisions of that class, the appending of the required number of decimal figures being resorted to to designate each minor subject by a fixed number so that its position in the classification never changes.

I may say, however, that in arranging the minor subjects, the same method was followed in grouping them in their regular and logical sequence. For instance, in the electric group, we started at our generating plants, then placed transmission lines, distribution lines, sub-stations, and customers' installations, each in regular order. This same treatment of minor subjects is followed throughout all divisions of the classification, so that in locating a subject the habit is soon acquired of finding it where it naturally belongs with relation to other subjects.

A Self-indexing Card System.—The third original feature and the one most important and useful in practice, is the self-indexing card system worked out for the complete classification. The self-indexing feature is followed out to some extent by the use of tabs in the condensed classification booklet for the use of local offices. This scheme of self-indexing does away entirely with the elaborate alphabetic index to subjects commonly used with the decimal system, and permits of the almost instantaneous location of a given subject.

Can Be Combined with Other Systems.—I desire also to point out that notwithstanding all subjects are given a definite and permanent number, this does not prevent an alphabetic, geographic or other special sub-division of those subjects when circumstances require. This is a purely mechanical arrangement in no way detracting from the original principle of our filing system. It makes possible a combination of the numerical, alphabetic and geographic systems. For instance, if the subject 638., Irrigation Service, becomes too bulky, an A-Z Folder for alphabetic sub-division is used for this subject so that correspondence concerning each customer can be filed alphabetically but will always, by the governing number 638., be kept in its proper position in the files.

Bonus System of Denver Tramway Co. for Power House Employes

A marked reduction in coal consumption has been effected by the Denver Tramway system through the operation of a bonus system for its power house employes. Previous to introduction of the bonus plan a new turbine of sufficient capacity to carry the maximum load of the system was installed. The saving in operating expenses resulting from this new unit and from the bonus system amounts to about $150,000 per year. This bonus system is described by W. E. Casey, Superintendent of Power, and E. Weber, Mechanical Engineer of the Tramway Co., in the Electric Railway Journal, from which the matter following is abstracted:

BONUS SYSTEM FOR POWER HOUSE EMPLOYES

1. Each employe on the power house payroll shall be entitled to a bonus, depending on the coal consumption per kilowatt-hour. The method of calculating this bonus will be explained in detail in the following paragraphs.

2. The coal used during each month shall be figured from the mine weights. The amounts of coal on hand in bins shall be estimated by the superintendent of power at the end of each month.

3. The kilowatt-hour output for the month shall be the entire amount generated for the month and shall include station power and light. The amount used for station power and light shall not exceed 2.5 per cent of the total amount generated if No. 8 turbine is in service and shall not exceed 4 per cent if No. 8 is in repair. Each 5,000 kw.-hr., or fraction in excess of this amount, shall be figured to increase the coal consumption by 0.01 lb. per kilowatt-hour.

4. Steam used for purposes other than power-house operation shall be converted to coal consumption; 5 lb. of steam used shall be estimated to be equal to 1 lb. of coal, or if such steam is paid for on a lump sum, then each dollar shall be considered equivalent to 1,000 lb. of coal.

5. The bonus system is based on the present load characteristic and load factor; if either one or both shall change materially it will constitute a cause for a revision of the bonus scale.

6. If the coal consumption in succeeding months varies more than 0.1 lb. of coal per kilowatt-hour, the chief engineer of the company shall make an investigation before a bonus is paid.

7. The bonus scale is based on lignite coal from the Leyden mine with a heat value of 9,500 b. t. u. per pound. If other coal is used the theoretical amount of coal used shall be figured to be in proportion to the heating value of the coal determined by a responsible chemist.

8. The amount of bonus each employe shall receive will be calculated by dividing the total bonus by the number of men on the power house payroll. In determining the number of men on the power house payroll, the following rule shall govern:

(a) Extra men taking the place of employes on the sick list shall not be figured as an addition to the number of power house employes unless on the power house payroll for a full month or longer. Employes who have been placed on the sick list for six days or longer shall not be entitled to a bonus, but shall be included in the number of power house employes as long as they remain on the power house payroll.

(b) Employes taking their vacation shall be included in the number of employes on the payroll and shall receive their bonus, but in case that it is necessary to employ extra men to take the places of men absent on vacation, the total amount of wages paid such extra men shall be deducted from the total amount considered in calculating the bonuses. These extra men shall be entitled to a bonus if they are on the power house payroll for a full month or longer; but shall otherwise be considered as extra men as outlined above.

9. If No. 8 turbine has to be taken out of service for repairs and the operating force is not at fault, the bonus shall be calculated in the following manner: The output of the old equipment

shall be taken at 4 lb. of coal per kilowatt-hour and the corresponding amount of coal deducted from the total monthly consumption. The resulting quantity of coal which will be found, divided by the kilowatt-hour output of No. 8 turbine, shall be used to determine the bonus.

10. If No. 8 turbine has to be taken out of service for repairs due to faulty operation, the whole engine room crew shall not be entitled to a bonus. In this case each fraction of a month needed to repair No. 8 shall be considered as a full month.

11. No power house employe shall be entitled to a bonus if, through his fault, damage is caused to the power house or any of its equipment, and if inspection of any equipment damaged has been overlooked by the foreman to whom this employe reports, he also shall not be entitled to a bonus.

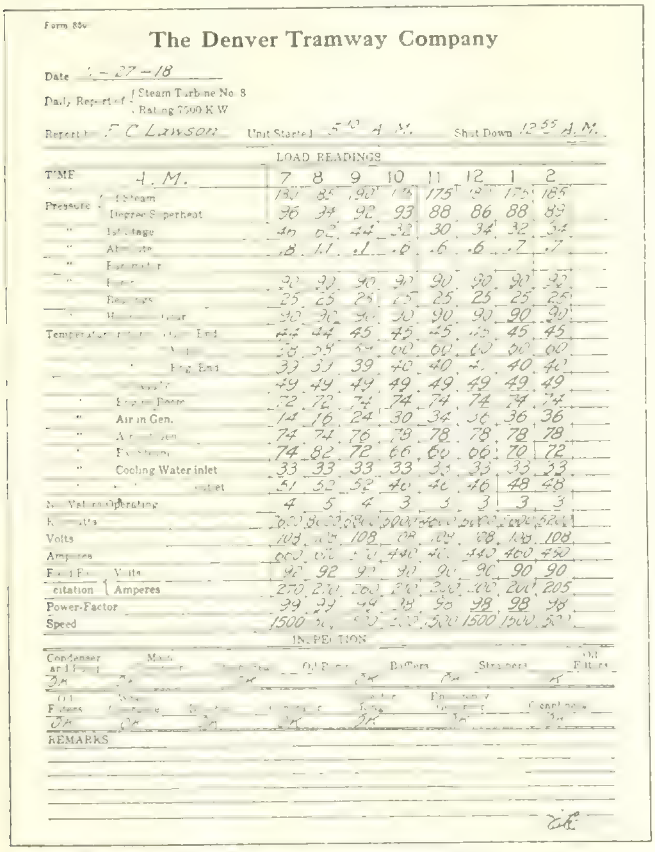
12. In case of power interruption, due to faulty operation, the bonus will be figured for the total number of power house employes, but the particular employes at fault for the interruption or bad operation shall not be entitled to any bonus.

13. Payment of the bonus shall be made in the following manner: 90 per cent of the total bonus earned will be paid out as outlined above, 10 per cent will be retained, and this sum so retained will be paid out semi-annually to all men who have been on the power house payroll for the half year or longer just preceding the date at which this last amount is paid.

14. The following bonus scale shall be used to determine the proper amounts:

Coal per kilowatt-hour pounds.	Total bonus per month.	Coal per kilowatt-hour pounds	Total bonus per month.
3.11 to 3.09	$ 2	2.75 to 2.73	$344
3.09 to 3.07	4	2.73 to 2.71	382
3.07 to 3.05	8	2.71 to 2.69	422
3.05 to 3.03	14	2.69 to 2.67	464
3.03 to 3.01	22	2.67 to 2.65	508
3.01 to 2.99	32	2.65 to 2.63	554
2.99 to 2.97	44	2.63 to 2.61	602
2.97 to 2.95	58	2.61 to 2.59	652
2.95 to 2.93	74	2.59 to 2.57	704
2.93 to 2.91	92	2.57 to 2.55	758
2.91 to 2.89	112	2.55 to 2.53	814
2.89 to 2.87	134	2.53 to 2.51	872
2.87 to 2.85	158	2.51 to 2.49	932
2.85 to 2.83	184	2.49 to 2.47	994
2.83 to 2.81	212	2.47 to 2.45	1,058
2.81 to 2.77	242	2.45 to 2.43	1,124
2.79 to 2.77	274	2.43 to 2.41	1,192
2.77 to 2.75	308	2.41 to 2.39	1,262

15. If any employe of the power house should find the bonus, as figured by the auditor, not to be correct, they can appeal to the chief engineer of the company, whose decision shall be final.



Form 850

The Denver Tramway Company

Date 1-27-18

Daily Report of { Steam Turbine No. 8, Rating 7500 K W

Report by F C Lawson   Unit Started 5 A. M.   Shut Down 12⁵⁵ A. M.

LOAD READINGS

TIME A. M.	7	8	9	10	11	12	1	2
Pressure Steam	180	185	190	[illegible]	175	180	175	185
Degree Superheat	96	94	92	93	88	86	88	89
" 1st Stage	40	62	44	32	30	34	32	34
" Atmosphere	.8	1.1	.1	.6	.6	.6	.7	.7
" Barometer								
" [illegible]	90	90	90	90	90	90	90	92
Bearings	25	25	25	25	25	25	25	25
" [illegible] Gear	90	90	90	90	90	90	90	90
Temperature [illegible] End	44	44	45	45	45	45	45	45
[illegible]	58	58	59	60	60	60	50	60
" [illegible] Eng End	33	33	39	40	40	[illegible]	40	40
[illegible]	49	49	49	49	49	49	49	49
" Engine Room	72	72	74	74	74	74	74	74
" Air in Gen.	14	16	24	30	34	36	36	36
" Air [illegible] Gen.	74	74	76	78	78	78	78	78
" F[illegible]	74	82	72	66	60	66	70	72
" Cooling Water inlet	33	33	33	33	33	33	33	33
" " outlet	51	52	52	40	40	46	48	48
No. Valves Operating	4	5	4	3	3	3	3	3
Kilowatts	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Volts	108	[illegible]	108	108	108	108	108	108
Amperes	600	[illegible]	[illegible]	440	[illegible]	440	460	450
Field Excitation Volts	92	92	92	90	90	90	90	90
Field Excitation Amperes	270	210	200	210	200	200	200	205
Power-Factor	99	99	99	98	98	98	98	98
Speed	1500	[illegible]	[illegible]	[illegible]	1500	1500	1500	[illegible]

INSPECTION

Condenser and Pump	Main [illegible]	[illegible]	Oil Pump	Batteries	Strainers	Oil Filters
OK	OK	OK	OK	OK		OK
Oil Filters	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Cleanliness
OK	OK	OK	OK	OK	OK	OK

REMARKS

Fig. 1—Record Form Used in Connection With Bonus System.

The coal used is a Colorado lignite with a heat value of about 9,500 B. t. u. per pound as fired, as indicated in the order. The load on the power plant is purely an electric railway load, of familiar characteristic form. The guarantees for the large turbine and condenser and some tests on the boilers made it probable that it would be possible to produce a kilowatt-hour with 3.1 lb. of coal as an average for a month, and this was adopted as the standard of fuel efficiency upon which to reckon the savings. If the large turbine is out of order and it is necessary to fall back on the auxiliary equipment, 4 lb. per kilowatt-hour is used as a standard

Checking and Economy Devices Installed.—The possibility of earning a substantial bonus every month caused every man to consider the losses and how to reduce them. The activity in the boiler room, for instance, was concentrated on stopping air leaks on boiler and economizer settings, while the engine-room force made it a point to use the proper combinations of generating equipment in service. The logsheet and other record forms, reproduced herewith, suggest some of the checking devices installed to assist in the campaign to cut down the coal consumption per kilowatt-hour. In addition recording economy draft gages, thermometers, steam flow meters, and CO_2 recorders are in use. The CO_2 recorder is used as a portable checking device. In connection with the portable draft gage it gives the desired information concerning the condition of the boiler setting, fire, etc. Flue-gas temperatures are taken at intervals. In the boilers the original Stirling arches have been replaced with flat arches, both for reasons of increased economy of operation and because it was believed the flat arch would stand up better and longer. The flat arches have proved to be superior in both ways.

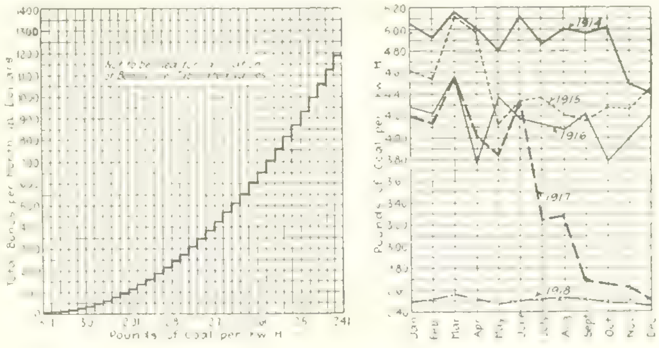


Fig. 2—At Left, Graphic Presentation of Power House Bonus Scale. At Right, Pounds of Coal Per K. W. H. Consumed in Denver Power House Since 1913.

As a result of the improvements the new turbine-generator takes care of all demands and the balance of the generating equipment is held in reserve. Three 750-h. p. Stirling boilers, together with their equipment, such as stokers, economizers, etc., have been removed and sold at a good price. Two more boilers of the same size, with economizers and chain grates and extra chain grates, are for sale now, and as they are in good condition they will probably bring a good price.

The results obtained can probably be best illustrated by the chart (Fig. 2), showing the coal consumption per kilowatt-hour at the present time to be approximately 2.5 lb. (in December actually reduced to 2.46 lb.) which represents a saving in operating cost of approximately $150,000 per year. These results are due partly to the better economy of the large turbine and partly to some other less costly improvements in the boiler room, but in no small degree to the introduction of the bonus plan.

Bonus Has Amounted to About $35 Per Man Per Month.—A few words concerning the adopted bonus system may be of interest. The coal consumption per kilowatt-hour is figured for the gross output of the station and includes all power used for the plant, amounting to 1.25 per cent of the gross output. If the coal consumption for net kilowatt-hours is desired the correction should be made.

One of the principles used in working up the scheme was so to arrange the bonus scale that the benefits derived from the special efforts of the employes would be divided evenly between the men and the company, and it was also considered better and simpler to pay all men the same bonus. This has amounted to about $35 per man per month above the regular salary. No especial competition between watches has been encouraged, but as the amount of bonus each man receives at the end of the month depends upon the combined efforts of all, no man is permitted by his companions to "lie [illegible] on the job." The [illegible] together with the [illegible] gives the men [illegible] so that they can tell where they stand [illegible].

It was early found that the [illegible] of the bonus system [illegible] to prevent the employes becoming over-zealous in their efforts, at the expense of the equipment. Thus, in accordance with the order, if No. 8 turbine has to be taken out of service for repairs due to faulty operation, no bonus is paid that month, and if damage is caused to the power house or its equipment through the fault of an employe, he is not entitled to participation in the bonus.

The bonus plan has now been in operation for a little more than one year and no difficulties have arisen. This is probably due to the fact that the whole matter was placed before the men and discussed at meetings prior to the inauguration of the plan, as it was considered very necessary that each man should understand fully the method of calculating his share. One point of interest is that our experience indicates that it is not good practice to pay the bonus on the regular pay day, for in spite of preaching and teaching some of the men form an idea that the bonus is simply wages and not an extra premium for increased efficiency. This point, as a matter of fact, reveals one of the danger marks of the whole bonus system.

Due to the improvements made in the plant, an operating crew of twenty-five men is now required, as compared with fifty-five men formerly. Shifts are now eight hours instead of twelve, and a two-week vacation with pay is granted every man each year. Without doubt the incentive offered by a bonus has increased the economies, and it has also produced a solidarity and co-operation among the operating force which has improved the quality of power service. Cleanliness at the plant is now considered a necessity. Inspection of all parts of the station is made with the greatest care, it being fully understood by the men that laxness may result not only in a pecuniary loss but also in a loss in reputation reflected readily in a decreased amount of bonus earned.

A great deal has been said in the past for and against bonus systems in general, and it is clearly understood that the same system is not suitable for every plant. Our experience, however, with the scheme adopted has worked out exceptionally well not only for both employes and employers, but also for the public in general, through a better utilization of coal and other materials, and an increased reliability in the power supply.

Rainfall Records for Muscatine, Ia., Cover 73 Year Period

Data on rainfall records at Muscatine, Ia., covering a period of 73 years were given by Mr. Wm. Molis, Superintendent of the Muscatine waterworks, in a paper presented April 16 at the meeting of the Iowa Section of the American Waterworks Association. The records show that the total rainfall and melted snow for the 73 years amounted to 2,702 in. or an average of about 37 in. per year. The minimum for this period was 23.04 in. in 1910 and the maximum was 74.5 in. in 1851. The totals and averages by 10-year periods are:

		Average.
[illegible]	444.51	44.45
[illegible]	[illegible]	38.95
[illegible]	346.30	34.63
[illegible]	425.54	42.55
1886 to 1896	336.40	33.64
[illegible]	314.40	31.44
[illegible]	318.95	31.89
1916 to 1919	96.30	32.10

The average for the 30 years from 1846 to 1876 was 39.34 in. In the next period of 30 years the average was 36.88 in., only 2.46 difference. In the period from 1900 to 1919 there were 33 days on which the rainfall of Muscatine was over 1.5 in. in 24 hours. The greatest rainfall occurred on March 16, 1919, when 3½ in. of rain fell. On Aug. 11, 1908, the rainfall amounted to 3.15 in.

Personals

L. D. Jeffries has been reappointed city engineer of Peoria, Ill.

F. G. Connelly has been appointed city manager of Esterville, Ia.

John Sam[illegible] has been appointed city engineer of Palestine, Tex.

E. W. Reiser has been appointed Borough engineer of Metuchin, [illegible]

R. T. Campbell has been appointed city engineer of Brainerd, Minn.

J. O. Endris, Jr., has been appointed superintendent of Waterworks for New Albany, Ind.

M. A. Turner, Secretary of the Chamber of Commerce of Ranger, Tex., has been appointed City Manager.

E. V. Willard, of St. Paul, has been appointed state commissioner of drainage and waterways for Minnesota.

George W. Bates, deputy city engineer of Lincoln, Neb., has been appointed Acting City Engineer, succeeding Adna Dobson, who died May 1.

Willis E. Ayres, consulting engineer, and Garner W. Miller, have become associated under the firm name of Ayres & Miller and will specialize in road, drainage and flood protection engineering, offices, [illegible] Randolph Building, Memphis, Tenn.

Francis E. Daniels, formerly Captain in the Sanitary Corps, and Camp Sanitary Engineer of Camp Lee, Va., has received his discharge from the Army and has returned to the Engineering Division of the Pennsylvania State Department of Health at Harrisburg, Pa.

Samuel A. Greeley, Hydraulic and Sanitary Engineer, announces that he has moved into new offices, at 39 W. Adams St., Chicago. Robert A. Allton, Major, U. S. Field Artillery, recently discharged, has resumed his place with the firm. Mr. Greeley has completed his work at Camp Custer.

Capt. C. R. Twigs, for the past 14 years City Engineer of Vicksburg, Miss., has resigned and has accepted a position with the I. R. Packard Construction Co. of Chicago. Capt. Twiss will have his office in Little Rock, Ark., and will have charge of the Arkansas contracts of the construction company.

Capt. C. R. Twiss, for the past 14 years City Engineer of Vicks-struction Division, Utilities Branch, of the Army, and has returned to the Technical Staff of Wallace & Tiernan Co., Inc., to resume charge of the Chicago office. Capt. Jennings' work in the army covered the supervision, operation and maintenance of water purification and sewage treatment plants in various camps.

Morris R. Sherrerd, for 24 years engineer and chief engineer of Newark, has been named chief engineer of the North Jersey District Water Supply Commission, his appointment to become effective July 1 at a salary of $10,000 a year. It is understood that Mr. Sherrerd will continue his work for the city in the capacity of consulting engineer, the position he holds at present with the Water Supply Commission.

Industrial Notes

Drusus H. Nichols and John C. Moore, formerly managing director and assistant director of the Allied Publicity Bureau, have organized the Nichols-Moore Co., general advertising agents, with offices at 11?5 Detroit avenue, Cleveland, O.

The American Steam Conveyor Corporation, Chicago, announce the appointment of N. B. Stewart as district representative in charge of the St. Louis territory. Offices have been opened at 708 Merchants-Laclede building, St. Louis, Mo.

H. M. Davison, who for the past fourteen years has represented the Hayward Company in its sales organization, has severed his connection with that company and has accepted the position of sales manager for the Ohio Locomotive Crane Co. of Bucyrus, O.

The Bailey Meter Co. has moved its main office and works from Boston to Cleveland, O. The Boston office, with H. D. Fisher as manager, is retained to handle sales and engineering service work in the New England District. For the present New York and Philadelphia Districts will be covered from Boston and all other districts will be covered from Cleveland.

Judge S. E. DeHaven, of LaGrange, Ky., an attorney, and for the past 6 years County Judge of the Fiscal Court of Oldham County, has resigned his position to become affiliated with The Canton Culvert & Silo Co. of Canton, O., as traveling salesman in Kentucky. L. W. Hurley, of Lansing, Mich., a corrugated culvert salesman of experience, has also accepted a position with The Canton Culvert & Silo Co. as Michigan culvert salesman.

The Chicago Bridge & Iron Co. has moved its general sales offices from the works and they are now located in the same space on the fifteenth floor of the Old Colony building, Chicago, that they occupied before the war. Lieut.-Col. Robert H. Murray, Major Charles S. Pillsbury, Lieut. J. C. Vosburgh, Lieut. George S. Sangdahl and Lieut. Ralph Green of this company are still over seas but are expected to return within the next few months.

The Neptune Meter Co. of New York has acquired a building from the Russell Motor Car Co. of Toronto, Canada, in which they intend to manufacture Trident water meters for Canadian trade. The president of the company is J. Herbert Ballantine and the manager director for the Canadian branch is William H. Randall, formerly superintendent of the maintenance and distribution department of the Toronto water works. The new plant is to be known as the Neptune Meter Co., Ltd.

News Letter

St. Louis Items.

Tom Newland is doing some road work near Fulton, Mo.

Geo. Reinke is bossing a job for Fruin & Conlon in the western part of the city.

Tom Blyth of Blyth Bros. came in from Farina, Ill., hunting a team job for their outfit.

Burke Construction Co. have started on the Louisiana State highway near Wilmot, Ark.

McCoy Bros. are doing some bank widening work for the Rock Island R. R. in central Kansas.

A. Waddell is moving his outfit on to a bank widening job on the Rock Island R. R. in Iowa.

P. J. Murphy is finishing up some old work on the Wabash R. R. between Moberly and Kansas City.

A. R. Gilliland will have his 9-team outfit idle in a few days Address him care of Koenig's Labor Agency, Kansas City, Mo.

Robert Oliver, 4430 Chouteau Ave., St. Louis, Mo., has an 8-team outfit that he wants to place on some work in this neighborhood.

Cameron, Joyce & Co., of Keokuk, Ia., have a lot of county road work near Fairfield, Ia. Want to sublet the concrete part of it.

C. F. Fitts, Bokoshe, Okla., reports his 11-team grading outfit idle. Wants to get in touch with some work in his part of the country.

R. E. Gurley of the T. W. Snow Construction Co., Chicago, stopped off here for a day on his way to Texas to look over a big job there.

Contractors when in want of labor or work for their outfits write Koenig's Labor Agency, 612 Walnut St., St. Louis, Mo., or 503 Delaware St., Kansas City, Mo.

Railways and Excavation Monthly Issue

ENGINEERING AND CONTRACTING

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HALBERT P. GILLETTE, *President and Editor* LEWIS S. LOUER, *Vice-President and General Manager*
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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year: but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The *articles* in the first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering and contracting field. The *articles* in the first and last issues of each month (1st and 4th Wednesdays) completely cover county engineering and highway engineering and contracting. The *articles* in the third and last issues of each month (3rd and 4th Wednesdays) completely cover steam and electric railway location, design and construction. See the "mast head" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation and Dredging
(b) Rivers and Canals
(c) Quarries and Pits
(d) Railways, Steam and Electric
(e) Management and Office System

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials

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Let Engineering Societies Become Postgraduate Schools

Bad habits and ignorance are the ball and chain upon the leg of progress. They make mental prisoners of millions of men. Although this will be granted with reference to foreign nations, it is not apt to receive ready sanction as applied to America. Yet it applies to us also, even if less extensively: for most of us are relatively ignorant, and all of us have habits that retard our progress.

One of our worst habits is unsystematic reading. We spend many hours every week gorging ourselves with daily newspaper stuff, entirely without definite purpose, unless the idle gratification of curiosity can be called purposeful. Even when we read scientific articles there is seldom any systematic plan to guide our reading. "Knowledge is power," but it is only a useful power when well assimilated and quickly available. The vast stores of technical knowledge in our engineering libraries are akin to great subterrenean beds of coal. They are immense reservoirs of power, but of no use to humanity until mined and converted into active energy for selected purposes. The great currents of periodic engineering literature are not unlike Niagara, flowing ceaselessly, capable of extensive use, but largely going to waste—and why? Because most men have no system by which to avail themselves of this knowledge, or, having a system, lack the habit of putting it into effect.

Few men will contest the statement that every one should exercise his muscles systematically in order to preserve health. Yet what a pitifully small percentage do exercise systematically. Failure to have acquired proper habits of exercise when at school accounts largely for subsequent failure to preserve health by exercise. Since good health is so great a desideratum, and since relatively few men exercise systematically, it can hardly be expected that many men will do systematically anything of less importance, such as reading to increase one's economic efficiency. It follows, then, that if the average man of any profession or business is to progress intellectually, he must put himself in the hands of teachers and trainers whose directions he will obey.

Very few of us have the will power to acquire a new habit unaided, even when we recognize its beneficent effect. We need mental trainers, and we need them not only during our school and college years but throughout life. Where shall the engineer find mental trainers? In most cases, if a mental trainer is found at all, it is in the person of the man under whom one works. Good as training under a superior often is, it seldom is adequate. Why should not the formation of desirable mental habits be the leading function of technical societies? Why should not every such society take a lesson from the recent war and organize training schools for its members?

Military training has

28 Pages = 40 pages

The 28 pages of articles in Engineering and Contracting contain as many words as 40 pages of the size and typography commonly used by other engineering periodicals. Ours is the same size of type and type-page as that of The Literary Digest—easily read, yet giving a large volume of reading matter per page. Our 28 pages of articles would fill 112 pages of the standard 6x9 in. text-book. It would take 10 such books of 580 pages each to hold all the articles printed each year in Engineering and Contracting, to say nothing of our weekly construction news.

[illegible] of certain desirable habits [illegible] of certain desir[illegible] developed during [illegible] by engineering societies, [illegible] better mental habits [illegible]

[illegible] of engineers in the [illegible] too much on the [illegible] but among our [illegible] Let us admit that [illegible] yet should know, [illegible] Let us take steps to improve [illegible] to enlarging their useful knowledge continuously and rapidly

Why Freight Rates Should Be Increased Fully 15 Per Cent

[illegible] and passenger rates 30 per cent higher now than in 1916, it is clear to students of railway transportation that another freight rate increase of fully 15 per cent is in sight. During the first three months [illegible] the amount guaranteed by the government, the deficit being $130,000,000 or at the rate of $520,000,000 a year. During the same period the gross earnings were at the rate of nearly $4,482,000,000 a year while the operating expenses (exclusive of taxes) were at the rate of $4,148,000,000 a year.

Since the deficit in the guaranteed earnings was at the rate of $[illegible] and since the gross earnings were at the rate of $4,482,000,000 a year, it follows that the gross earnings would have to be increased nearly 12 per cent in order to wipe out the deficit.

About three-fourths of the gross earnings come from freight; hence, if passenger rates are allowed to remain as they are, freight rates must be raised 15 per cent in order to wipe out the deficit in the return guaranteed to the owners. That this will occur is almost inevitable. The wages of the average railway employe are now 84 per cent higher than they were before the war. All other operating expenses are up in proportion. An average increase of 50 per cent in freight and passenger rates is clearly no more than fair, unless the railways are much overcapitalized. Experienced railway appraisers are almost unanimous in stating that there is no likelihood that the Interstate Commerce Commission appraisals will disclose overcapitalization, taking the railways as a whole.

Director General Hines has intimated that railway transportation may increase sufficiently to make it unnecessary to raise rates, but he has given no data in support of such a hope. On the other hand the available data point in the opposite direction. Thus, for the first quarter of 1916 the freight of the railways was 80 billion ton-miles as against 85 billion for the first quarter of 1919, an increase of 6 per cent. It is true that for the first quarter of 1919 the ton-mileage was 10 per cent less than for the corresponding quarters of 1917 and 1918, but those were years made abnormal by our great efforts to win the war.

Finally (and this has not been sufficiently emphasized) American railways were financially starved for many years prior to the war. They should have been allowed to earn enough to build up a substantial depreciation fund, which they never did. Having neither a depreciation reserve nor a surplus of adequate amount, the railways have lived from hand to mouth. They have lacked both the capital and the incentive to make improvements in the art of transportation comparable with those made by the American Telephone and Telegraph Co. (the Bell system) in the art of communication. Yet no experienced engineer doubts that railway transportation is susceptible of being enormously improved both as to speed and as to economy. Read, for example, in this issue the editorial on A Remarkable Economic Improvement in Street Car Transportation, and bear in mind that similar possibilities exist in the railway field.

Electrification of steam railways alone offers wonderful opportunities for improvement, but the penny wise policy of our rate making commissions has so throttled the ambition of railway owners and managers that they have done almost nothing toward electrifying their roads.

A liberal policy as to railway rates will do more than anything else toward ultimate reduction in rates. The greatest incentive to progress is a liberal, a princely reward for economic success.

A Remarkable Economic Improvement in Street Car Transportation

The most noteworthy advance in street car operation during the last few years has been the introduction of the one-man, light-weight car. This type of car has effected a saving in operating expenses ranging from 20 to 40 per cent on the first cost of the car. In addition it has increased the patronage of car lines, because of the greater frequency of service. In some cases the combined increase in revenue and decrease in operating expenses has been great enough to pay for the new cars in 1.5 years! These are data given out by H. G. Bradlee, president of Stone & Webster Management Corp., a company that manages more than 50 public utility plants.

Mr. Bradlee states that prior to undertaking a scientific study of street car design, their companies were operating cars that weighed as much as 1,500 lbs. per passenger seat. Within a few years they were able to reduce the weight to about 750 lbs. per seat for double truck cars and 450 to 600 lbs. per seat for single truck cars. Then, finding that London motor buses weighed only 300 to 350 lbs. per seat, the Stone & Webster Corp. resolved to attain a similar weight for their street cars. Their Mr. Birney studied automobile design, and secured the co-operation of car manufacturers and of two great electric manufacturing companies, the Westinghouse and the General Electric. The outcome was a car that weighs 13,000 lbs. and seats 35 people, or 370 lbs. per seat, as contrasted with the old 35,000-lb. car seating 40 people.

As an example, a line operating 2 heavy two-man cars at 30 min. intervals, is changed to operate 3 light one-man cars at 15 min. intervals, resulting in a saving of $3,500 a year in operating expense, exclusive of fixed charges. The three light cars cost $3,500 each, at pre-war prices. A 50 per cent increase in annual car mileage has caused more than a 25 per cent increase in the number of passengers carried. There is not only a 60 per cent saving in power, but even with the increased number of cars there is a reduction of 30 per cent in the peak load on the generating station.

The light one-man car has given excellent satisfaction in cities of all sizes up to 300,000, and there is no reason why much larger cities will not find it satisfactory for at least three-fourths of the traffic.

Not long ago Ford criticized the steam railways for not reducing the weight of their rolling stock. That his criticism was well founded seems to be borne out by the pronounced success of the light-weight electric passenger car.

A Certain Condescension Among Engineers Toward Advertisements

It is an axiom of economics that every fair bargain between a seller and a buyer is of advantage to both. If so, it follows that prospective buyers should welcome the efforts of salesmen to create interest in their wares; and by a parity of reasoning, prospective buyers should gladly give time to the study of catalogs and advertisements of articles that they might use. Yet it is unfortunately a fact that many prospective buyers are inclined to repel nearly all efforts to arouse their interest in things offered for sale. Doubtless this habit is consequent upon the frequent and excessive insistence of salesmen; but it is well to realize, nevertheless, that it is a bad habit to be perpetually antagonistic to sales arguments and sales literature.

Among professional men in particular there is an excessive amount of resistance to salesmanship, whether it takes the form of the printed or of the spoken word. There is, in fact, a tendency to look down upon salesmanship and advertising. This tendency is manifested in many ways. Thus, an engineer who becomes an engineer-salesman or an advertising writer, loses professional caste among engineers; and this occurs even when he still applies engineering skill of high order. Or, again, it is seen in the complaints often made by engineers that there are more pages of advertising than of articles and news in technical magazines. If engineers realized that advertisements are either educational themselves or open the door to veritable libraries of useful knowledge—i. e., catalogs, etc.—they would welcome an abundance of advertising in their magazines. Moreover, they would make it a practice to send for catalogs and study their contents.

There are scores of machines and devices about which most engineers are either largely or completely ignorant, in spite of the fact that their ignorance is costing themselves or their employers a pretty penny every year. Let us give an illustration that nearly every engineer can appreciate.

Tracings and blue prints are almost invariably filed either in rolls or horizontally flat. In either case more floor space is taken up than when they are filed vertically flat. Ask any engineer why he does not use vertical files, and his answer almost invariably is that there is no satisfactory vertical file. Yet he is wrong. In spite of the fact that there has long been advertised a vertical file that completely overcomes all objections, he is either ignorant of its existence or does not know the principle upon which it depends for its success. Ask yourself whether you can describe, even crudely, the file we refer to. Then verify your answer by reading the description of it in our section on management and office system.

Putting it bluntly, the great majority of us are startlingly ignorant of devices and machines that we should be using. Our ignorance springs largely from a certain condescension with which most us look down upon advertisements. Few of us have ever taken the pains to trace the cause of this condescension or even to ask whether it may not be evidence of mental smallness.

An Industrial Slogan for America—Continuous Education

In a recent advertisement of Swift & Co. we read:

"At the general office in Chicago, every boy is given an hour's schooling daily on company time, such work being accredited by the high school authorities, in securing a two-year commercial course diploma."

This plan of continuing the education of company employes at company expense seems likely to be adopted widely, nor will it be limited to boys of high school age. Every argument in favor of having boys study an hour daily on company time is equally sound when applied to grown men. All that interferes with general appreciation of this fact is prevailing false ideas as to education. Most men not only speak of their education in the past tense but actually cease studying after graduation. Of course they inevitably acquire additional knowledge after graduation, but the process is incidental rather than systematic.

America already leads all other nations industrially, but the average American industrial organization is far behind the best of its kind. The same holds of average American individuals, of every class, whether they are employers or employes, managers or managees. If only the efficiency of the average man could be raised to the level of the best—! Yet such an ideal is not purely visionary; it is, in large measure, realizable. But how? By continuous education and training of all manual and mental workers.

The great obstacle to the execution of a plan of universal training is mental inertia, or aversion to a change of habits. In addition there is to be taken into account weariness and staleness that follows the ordinary day's work. This last named obstacle would be completely overcome were employes required to spend a portion of their working time every week learning how to become more efficient producers and better members of society.

It would be an interesting experiment, and one that might have revolutionary consequences, were some company to require all its employes to cease their regular routine for one hour each day and submit themselves to a course of study and mental discipline under competent instructors. It is our belief that within a short time the employes would be executing more work in seven hours' routine than had formerly been accomplished in eight, and that within a few years the output of the same number of employes would be increased fully 50 per cent, provided substantial wage increases accompanied an increased output.

A solitary mountain of great height rarely juts up from a plain, or even from among low hills. Pike's Peak is but one among hundreds of surrounding peaks of an eminence almost as great as its own. So, too, where the average level of trained intelligence is high, there will usually be found the greatest number of geniuses. Hence it is inferable that if we were to give all our managers and workers a continuous education, our percentage of Edisons and Burbanks would increase steadily.

Continuous education—let that become the industrial slogan of America.

The Municipal Railway System of San Francisco

To the Editor: My attention has been called to an editorial appearing in the issue of Engineering and Contracting of Feb. 19 entitled "San Francisco's Municipal Railway Is No Gold Mine."

This editorial is so unfair and misleading, due to the tone and the suppression of part of the report, that I cannot let it pass without comment. I am therefore setting forth in this letter a few facts relative to the results achieved in the operation of our municipal railway system, and if you will publish the statement it will permit your readers to know the truth and enable them to form their own opinion as to whether or not the result of municipal ownership of street railways in San Francisco is as disastrous as your editorial would make them believe.

As you mention in the body of the statement, the railway pays no taxes, but its charter requires such charges to appear in the report. Without these charges the same annual report shows a net profit for the year of $31,084. Further, while the published report includes these charges for the purpose of comparing the results of operation with privately owned properties, when this comparison is made it should be pointed out that the ordinary privately owned and operated railway system does not provide a depreciation reserve of 14 per cent of its gross receipts in addition to maintaining the property in a first class operating condition. In other words, there is $264,727 charged into operating expenses in the municipal railway report as depreciation, which is in reality money transferred to a reserve fund.

Reviewing the results of municipal ownership and operation of street railways during the past 6 years, the following facts are significant:

For the construction of these municipal railways San Francisco has bonded itself for $5,500,000. From the operating revenues of the system, in addition to paying all operating expenses and maintenance charges, the city has paid the interest on the bonds and has redeemed the bonds as they have matured to the extent of $404,000; has constructed extensions to the system at a cost of $800,000, and has created a reserve fund for depreciation and insurance of $1,000,000.

The above data may serve to indicate that San Francisco's municipal railway is in a healthy and sound financial condition. There are few railroad systems under private ownership that are in as good position at this time as is evidenced by the nationwide agitation for public recognition of the fact that the 5 ct. fare is no longer commensurate with the increased cost of giving service.

I would further point out that the financial benefits to the community of municipal operation of the street railways are not all reflected in the railway report, for in addition there are material gains in the tax yield due to the increase in the assessed value of the property served by these railways, particularly in those outlying districts which were either without transportation or with very inadequate service.

In addition to the financial benefits, the people of the community are enjoying a higher class of service than they did prior to the city's going into the transportation business. This is true not only on the municipal system, but applies equally to the privately operated system who have likewise improved their service owing to the element of competition.

M. M. O'SHAUGHNESSY.
City Engineer.

San Francisco, Calif.

The Causes of Railway Curve Resistance

[illegible] the [illegible] Engineer of the Ca[illegible] [illegible] the problem of curve [illegible] which throw [illegible] have been unable to [illegible]

[illegible] to account for [illegible] centrifugal force is as[illegible] [illegible] account for it on the basis of obliquity of traction—the tendency of a train passing around a curve to draw itself straight. Still others believe that the skidding of the wheels incident to the different [illegible] wheels of an axle [illegible]

Mr. Sullivan discounts the centrifugal force theory because with proper superelevation of the outer rail the action of centrifugal force is simply to place more of the weight of the car body on the outer rail. He considers the obliquity of traction theory absurd since a locomotive will push practically as many cars around a curve as it will pull, and all experience has been that it is the outer rail head rather than [illegible]. Regarding the skidding of the wheels along the rails, Mr. Sullivan makes the point that, even assuming a coefficient of friction of 22 per cent, only one-fourth of the force usually assumed to represent curve resistance would be accounted for.

His own theory is that the reason that the outer wheels exert a pressure against the outer rail on a curve is the fact that a revolving cylinder tends to rotate on a straight [illegible] to the axis of rotation. In other words, he attributes the attempt of the outer wheel flanges to climb the rail head as due to the gyroscopic action of the wheels.

Mr. Sullivan quotes several statements from A. M. Wel[illegible] [illegible] Theory of Railway Location" and shows how some of the conclusions made by this well-known author do not fully agree with modern experience.

In order to test some of his own theories, Mr. Sullivan had a long 8° 10" curve carefully measured. He then calculated what the diameter of the inner and outer wheels would be to make them exactly proportional to the length of the inner and outer rails on this curve. These wheels were then turned accordingly, with a standard flange but with a flat tread; they were put under a steel flat car 36 ft. 10 in. long with a tare weight of 31,200 lb. and a live load of 99,000 lb. of steel rails. The first experiments made with this car were with the idea of testing the tractive force necessary to move it. It was apparent from the start that the equipment of the dynamometer car used was not delicate enough to measure small pressures accurately. Mr. Sullivan, therefore, abandoned the idea of attempting to get a definite figure in pounds per ton with this machine, but the results prove conclusively what he expected, viz., that the resistance on the 8° 10" curve was only 50 to 60 per cent of the resistance on straight track.

The next test consisted of pulling another flat car, similar in all details except that it had standard trucks which were in very good shape. The dynamometer car results indicated, as expected, that the resistance on straight track was only 40 to 50 per cent of the resistance on the curve. The most important feature of these tests was the fact that the trucks with the special wheels never pressed against the head of either the inner or outer rails while going around the 8° 10" curve, but ran exactly as true as the ordinary truck runs on a straight track and this was true regardless of speeds from 5 to 25 miles per hour, thus proving, apparently, that the rectangular shape of the wheelbase, especially so for the short wheelbase of a freight truck, has very little or nothing to do with causing the pressure of the wheels against the outer rail.

Some tests were made with a view of attempting to measure the amount of skidding of the wheels. A flat car with a gross weight of 129,100 lb. was run a distance of about 600 ft. in both directions over the above mentioned 8° 10" curve at a speed of about 4 miles an hour. The revolutions on all the wheels were counted and measurements taken to show how far they would have to go to complete 70 revolutions. Table I gives the results of these measurements.

The object in giving this matter to the public is to revive interest in this subject, bring out discussion, and if possible get more information, as it is only when the actual causes of trouble are really understood that the proper remedies can be applied. The second reason is to call the attention of operating officers of railways to the fact that it is a waste of fuel to haul cars over railways, the wheels of which are not running true.

Mr. Sullivan is convinced that the greater portion of the curve resistance is caused by the pressure of the flange against a single rail. Therefore, the mating of wheels or the setting up of trucks not properly true that cause the flange on one wheel of an axle to wear sharp is not only shortening the life of the wheel but is costing the company considerably more money to acquire this undesirable result.

The following conclusions are drawn by Mr. Sullivan from the experiments:

1. All outer wheels of railway equipment exert a pressure against the outer rail when rounding a curve.
2. The cause of this pressure is the tendency of a cylindrical body to rotate in a straight line at right angles to the axis of rotation.
3. There is never any skidding of either wheel of the leading axle of a truck unless it is a forward skidding of both wheels caused by the resistance to rotation being great enough to cause a slight retardation to rotation, which results in an apparent forward skidding.
4. There is no skidding of the outer wheel of a rear axle: in general, any skidding that does take place is on the inner wheel of the rear axle.

Use of Pack Mules for Carrying Rock.—Pack mules, according to a note in Professional Memoirs, proved of great service in carrying rock in connection with the operations of the 602d Engineers of the U. S. Army. It was not possible to use wagons on the road for transporting rock, due to the fact that there was but one track and it was not considered advisable at that time to construct a turn road for the empty wagons, which were unable to return over the crowded trail. The boxes which had been made for transporting rock on pack mules were soon discarded and sandbags filled with rock were substituted for the boxes. The method, states the note, is highly recommended for use on all congested highways when the road must be completed under the wheels of moving vehicles. It is believed that the 24 mules used on the job transported more rock than was transported by 300 of the Pioneer Infantry. Each mule carried a load of 4 sandbags full of rock. Bags of rock were placed on the upper rail and slung with a lyer rope only. Mules worked individually with one man to lead them, and moved in and out and about traffic, and were easily loaded and unloaded.

TABLE I.

[illegible]	2 [illegible]		3 Seventy times circumference of wheels in feet taped in field close to flange.		4 Difference between distance measured on rail and 70 times circumference.		5 Seventy times circumference of wheels in feet as officially taped after test 1 in. from base of flange.		6 Difference between distance measured on rail and 70 times official taping of circumference.	
		Inner.	Outer.	Inner.	Outer.	Inner.	Outer.	Inner.	Outer.	Inner.
No. 1....	605.88	601.68	602.29	602.29	[illegible]	—0.61	601.01	600.83	+4.87	+0.85
[illegible]	[illegible]	[illegible]	605.21	605.21	+0.37	—3.82	604.11	604.11	+1.47	—2.72
[illegible]	[illegible]	601.73	[illegible]	602.29	+3.63	—0.56	601.38	601.01	[illegible]	+0.72
[illegible]	[illegible]	601.27	603.02	603.02	+2.44	—1.75	602.11	602.29	+3.35	—1.02
No. 1.........	604.67	[illegible]	602.29	602.29	+2.38	—1.81	601.01	600.83	+3.66	—0.35
[illegible]	[illegible]	[illegible]	605.21	605.21	+3.67	—0.53	604.11	604.11	+4.77	+0.57
[illegible]	[illegible]	[illegible]	602.29	602.29	+2.34	—1.86	601.38	601.01	+3.25	—0.58
[illegible]	[illegible]	[illegible]	603.02	603.02	+4.06	—0.13	602.11	602.29	[illegible]	+0.60

Draglines Will Handle 2,000,000 Cu. Yds. of Excavation for Deepening Miami River

In connection with the flood control project of the Miami Conservancy District, work is now under way on the improvement of the Miami River through Dayton, O. This river work involves the deepening of the channel, the raising and widening of levees, and the replacement of irregularities in the course by smooth curves. The improvement will extend for 8½ miles along the river and will require more than 2,000,000 cu. yd. of excavation, about one-half of which will be used in improving the levees, and the remainder will be used for filling in certain tracts of low ground behind the new levees. The methods employed in carrying out this river improvement are described in the May issue of the Conservancy Bulletin, from which the matter following is abstracted:

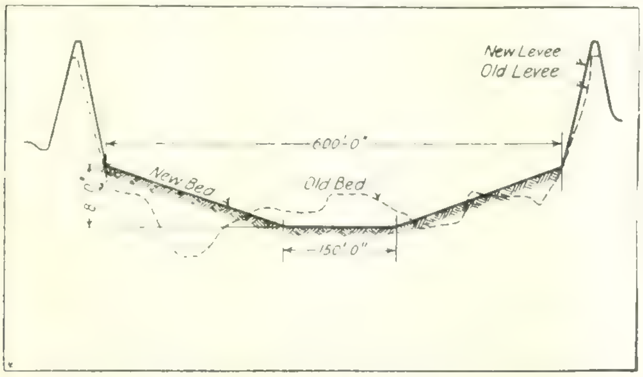


Fig. 1—Typical Cross Section of Miami River Improvement.

A typical cross section of the new channel is shown in Fig. 1. It gives a total width from foot of levee to foot of levee of 600 ft., and a total height from the river bottom to the top of the levee of 28 ft. The bottom of the channel is level for a width of 75 ft. on each side of the center line, then rises on very flat uniform slopes each way to the foot of the levee. With this section of channel a flood 40 per cent greater than that of 1913 will still fall 3 ft. short of the tops of the levees.

The river channel before the flood of 1913 had been improved by various means, including levees, stone or concrete walls, and stone or concrete "revetments" to protect the inner slopes of the levees in various places. Some of these old improvements had been so carried out that they could well be made part of the new plan, and this was done wherever it seemed best, in order to reduce expense.

The channel bottom next the outside levee in the bends of the river will be protected by concrete revetments. These revetments are really flexible concrete mattresses so constructed that if the river starts to undermine them at the foot of the slope, the mattresses will drop into the excavation to protect the threatened locality. This flexibility is obtained by making the revetment of concrete blocks 5 in. thick, 2 ft. long, and 1 ft. wide, these blocks being strung on steel wire cables so as to present a smooth, yet flexible, paving for the channel slope adjacent to the levee. The levee slope itself will not have the flexible revetment, but will be paved along its lower portion with continuous concrete pavement.

New walls are used in various places to carry up the old walls to a higher elevation, to top out the upper edge of the old revetment, or to top out and reinforce the new levee, that type of construction being adopted in each case, which, consonant with safety, will effect the improvement with the greatest economy.

The material constituting the improved channel bed and the river slopes of the levees is excellent, being mainly composed of gravel, which fortunately here occurs in the old bed of the river.

The machines used for the river excavation are two Class 175-B Bucyrus dragline excavators with 3½-cu. yd. buckets, and booms of 125-ft. and 135-ft. lengths respectively. The machines weigh over 175 tons each and are equipped with electrical machinery developing in all about 350 h.p. In a river the size of the Miami, these dragline machines can place a large part of the material to be excavated in its final resting place in levee or bank by simply swinging the machine on its pivot and dumping the load. Where the distance from the point of excavation to the levee under construction is too great to be reached by simply swinging the machine, the difficulty can be overcome by handling the same material twice with the dragline. Thus in one instance the dragline moved down the river parallel to and east of the center line, excavating the middle portion of the river channel and depositing the excavated material in a long windrow at the east limits of the boom's reach. The same machine later returned along a course parallel to and east of this windrow, picked the material up again and dropped it into its final resting place in the new east levee of the river. By such a process of double handling, these dragline machines can drop material over 500 ft. from the point of original excavation; by triple handling between 600 and 800 ft.

A considerable part of the material, however, cannot be thus disposed of near the point in the river from which it was excavated, due to the fact that through the main part of the city adjacent buildings, streets, or other improvements do not leave space for dumping the excavated material. This material will have to be transported along the river and

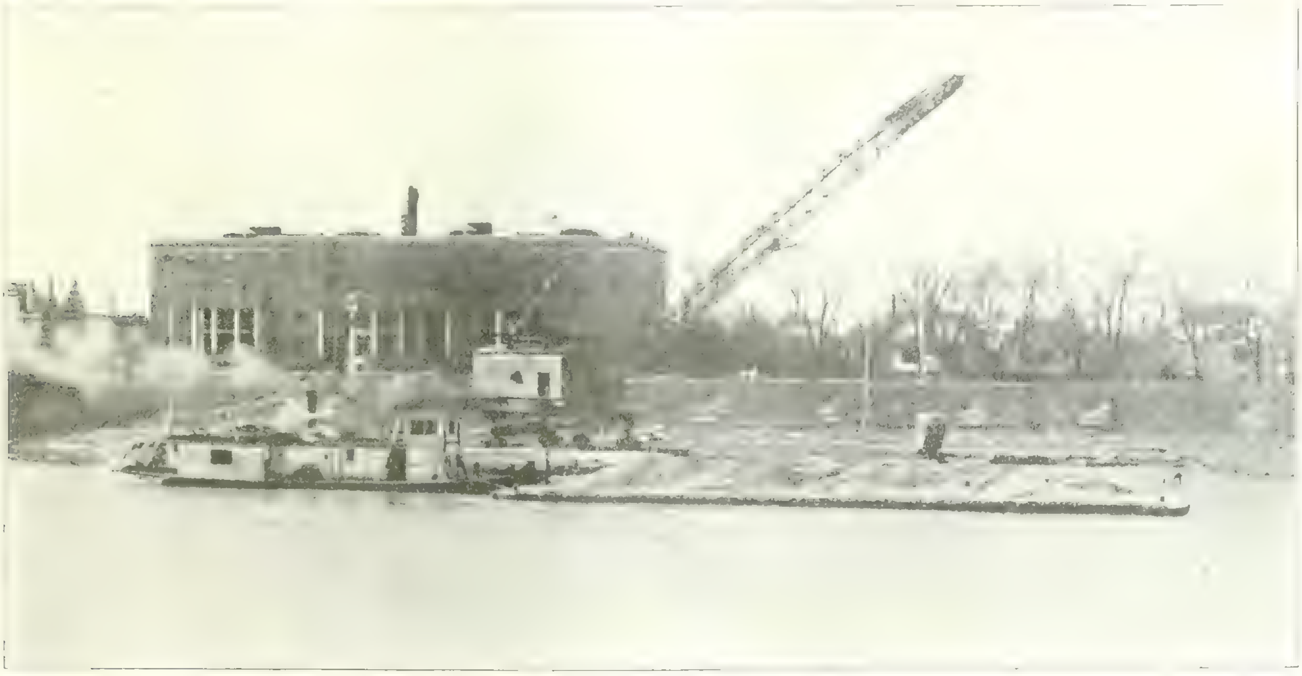


Fig. 2—Steamer and Scow Loaded With About 250 Cu. Yd. of Earth.

The dragline excavator is just beginning to load a second scow. The material is unloaded by a second dragline similar to the one seen here, and dumped into one of the levees.

[illegible] the levees at one or other [illegible] This transporta- [illegible] and steamboat on the river. [illegible] built, [illegible] ft. by [illegible] ft. in size, and which draw, full-loaded, 5 ft. of water. As the river at an ordinary low stage does not provide sufficient depth for these boats, a temporary dam has been built just above the mouth of Wolf Creek, which raises the water at [illegible]

[illegible] wheel steamer of [illegible] was built, 20 ft. wide, 70 ft. long, and 3 ft. deep. Its double engines have 8-in. by 42-in. cylinders, developing about 125 h.p., and supplied by a [illegible] The steamer draws 21 in. [illegible]

[illegible] is being built, on which a No. 9½ Bucyrus dragline excavator will be mounted for auxiliary work on the river.

For most of the excavation above Main St. at Dayton, now nearly completed, the draglines have traveled on rails laid upon mats, in the usual manner, the mats being laid along the shore. Now and then the machines have had to cross the river, which they did by building up the bed into a moving island. For most of the work which remains, the loading dragline will be mounted upon an additional scow, 40 ft. by 80 ft. in dimensions, by means of which it will be shifted [illegible] as the work proceeds.

The total amount of material excavated from the bed of the stream to date in the Dayton river improvement is 340,000 cu. yd., 238,000 cu. yd. of which has been deposited in the levees and spoil banks. 192,900 cu. yd. have been moved twice by the dragline in getting it to its final place in the manner explained above. This makes the total material moved by the draglines 532,000 yd.

The work is being carried on by C. A. Bock, Division Engineer, and E. L. Chnadler, Assistant Division Engineer, under the general supervision of J. H. Kimball, Construction Engineer.

It Isn't Economical to Build Cars to Last Forever

In visiting different railway properties in this country one cannot fail to be impressed by the large number of old cars and antiquated types of motors and equipment still in service. With some types of electrical apparatus, as for instance incandescent units, engineers have long since worked out curves which show that it is cheaper to replace them with new lamps after they have had a certain life, rather than continue them longer in service. Manufacturing engineers, from time to time, have tried to impress upon electric railway operating officials the desirability of similar treatment for their entire equipment. It is very difficult, however, to convince a general manager that any equipment which will still operate should be scrapped in order to give way for a more modern type.

At a recent meeting of a committee of the American Electric Railway Engineering Association there was considerable discussion regarding the light construction which is being employed in certain recent types of cars. This suggests that perhaps it would be much better for the electric railway industry if the equipment, instead of being built to last 20 or 25 years, was built to last only half as long. The first cost would then be considerably less and there would not be the temptation to continue the equipment in service after its period of usefulness had ended. The automobile business has progressed as rapidly as it has, partly at least because the cars wear out quickly and can be readily scrapped and new apparatus installed.

In this connection an editorial in the July 7, 1917, issue of this paper entitled "Are City Cars Made for Collisions or Passengers?" is apropos. As was pointed out in this editorial, when railways learn to look upon their cars as production units then they will put less money into dead metal and more money into equipment which will produce high acceleration, rapid braking and economical operation. Operating officials should learn to look upon their car equipment as a means for delivering a passenger-mile. Any method of delivering this in the most economical and attractive manner is the best for their railway property.—Electric Railway Journal.

Tie and Timber Conservation in Canada

Mr. H. K. Wickstead, of the Canadian National Railways, writing in The Canadian Engineer, makes some observations on the future of Canada's timber supply. The following is abstracted from his article:

For a decade or more, the question of a future tie supply for the railways has been a serious one in the United States, owing to the rapid depletion of the forests, and within the past 5 years the anxiety has spread to Canada.

Assuming the average life of ties, for instance, at 6 years, the Canadian Northern system alone will need over 4,000,000 per annum, and the other two trunk roads something more than this, or say from 12,000,000 to 15,000,000 in all. Our northern forests cannot stand this drain for any length of time. Much less can we hope by any reasonable efforts in reforestation to keep abreast of the demand. The timbers used are slow-growing ones, with the exception of jack-pine, and even this takes 30 to 40 years to attain sufficient size.

There are two means by which we can stave off the impending famine, one by increasing the life of the timber tie, and the other by using some other material altogether, such as steel or concrete. Such experiments as have been made in the latter expedient have not been altogether satisfactory from the point of view of economy, even where they were physically.

The first expedient is the only one which has come into any considerable use on this continent, and it has usually taken the form of injection of creosote into the pores of the wood. This acts as an antiseptic, preventing the bacterial growth which results in decay through what we are accustomed to call "rot."

It is quite conceivable, I think we may say probable, that the settler in New Ontario, Northern Saskatchewan or Alberta, will find it profitable to conserve the forest on a considerable portion of his land, cutting from year to year only the mature timber so as to encourage the young growth.

Balsam is to this day the principal cut of the little country mills in northern Nova Scotia for home use, and is an excellent material for inside carpentry. Spruce is probably the finest known material for spars, and only its perishability prevents it from making a cleaner, straighter and stronger telegraph pole than the crooked, twisted cedars we are now using. Birch is already coming to its own in the manufacture of furniture.

Our northern settler has been in the habit of burning up most of these timbers as almost worthless, in order to grow potatoes in their stead. A century ago, the settlers in southwestern Ontario thought much the same about the white pine and the black walnut, and some of the wealthiest residents in that portion of the country today are those whose fathers, either by accident or design, left some of the original forest standing.

Even before the war and the recent enormous advance in prices, we had become so impressed with the growing scarcity and increasing cost of timber ties that we had been making all kinds of experiments with metal and concrete ties, not in order to cheapen the first cost but to lengthen the life of the tie and so make its annual cost less.

If we go into concrete at all, it has always seemed to me that we should alter our whole system of support to a longitudinal instead of a transverse bearing, and this again would alter the most economical form of rail to be used. Possibly, we might, with a long stringer of concrete, giving us the necessary stiffness and rigidity, dispense with enough steel to pay for part of the increased price of the bearing, but imagine what we should get into in the way of drainage and precautions against frost heaving in our climate!

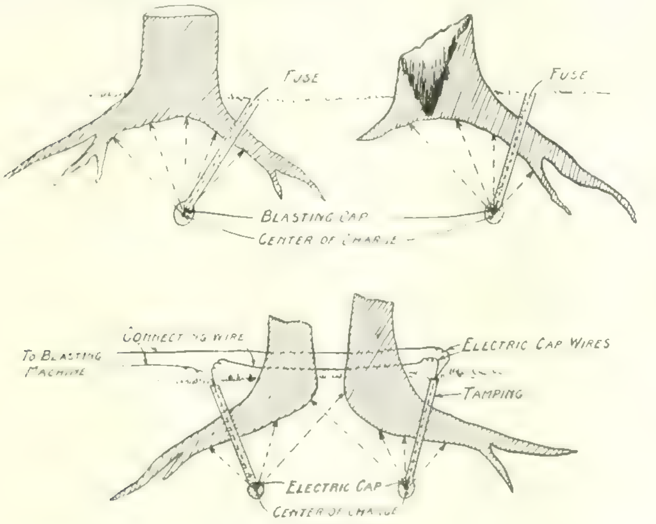
I have seen reinforced concrete ties doing very excellent work in the tropics, but our frost conditions alter the whole aspect of the matter. Shimming upon the top of a concrete tie would be a very difficult matter from drawing the spikes out of a wooden tie and putting longer ones in, or, as we have to do sometimes, putting a complete new tie on top of the old one.

I am afraid that for many years to come we must continue to use wooden ties—at any rate, on all but the most perfect and most heavily congested parts of our railways—and this being the case, and the supply diminishing while the demand increases, it behooves us to make them as long-lived as possible.

Methods and Costs of Stump Removal in Land Clearing

For a number of years the agricultural experiment station of the University of Wisconsin has been making investigations of land clearing methods. In connection with this the station has carried out much experimental work and also has given many land clearing demonstrations. The results of this work are summarized in a recent bulletin of the station, compiled by F. M. White and E. R. Jones from notes by Carl Livingston, L. F. Livingston, Alfred Matheson and Joseph Hussey. The matter following has been abstracted from the bulletin.

Dynamite in Stump Removal.—Investigational work has made it possible to separate the uses of dynamite for stump removal. Under general conditions the amount of dynamite required in each method decreases in the order in which they are listed:



Placing the Charge.

Upper left—Cap and fuse method of loading under a solid, firm, evenly rooted stump. Upper right—Top-rotted or hollow stump with roots rotted away on one side. Lower—Separated roots of a top-rotted stump. Dotted lines show the direction of the explosive force. Electric cap could be used in each case.

1. Blowing out the stump completely.
2. Cracking the stump to pull it with a team on a straight line.
3. Cracking the stump to pull it with a "block and line."
4. Cracking the stump to pull it with a stump puller.
5. Cracking the stump after it is pulled with a stump pûller.

Regardless of purpose, success depends on the proper handling and use of the explosives.

To blow out a stump completely, the stump, the soil, the tools, and the explosives must be considered. It is first necessary to know the stump—its kind, age, and condition; the soil—its character and moisture content; the best tools and their use; and the lowest priced dynamite that will do effective work.

The most economical results in stump blasting are obtained with a firm, dead, lateral rooted stump in moist clay, with all the fibrous and smaller roots decayed. A charge of 20 per cent dynamite, properly placed and thoroughly tamped under such a stump, will throw it out in pieces which can be handled easily and burned. As the character of the stump and soil change, methods and tools vary.

Methods of Loading and Firing.—A charge of dynamite placed under a stump to blow it completely out of the ground should be located where the stump is tightest. This location is not necessarily under the center of the stump.

A single charge properly placed so that the force of the explosion will be applied where the stump is tightest is to be recommended for stumps not too large, and without widely spread lateral roots, or when the smaller top-rotted stumps have their lateral roots joined at the crown. The firing can be done with an ordinary No. 6 cap or a No. 6 electric cap.

The electric method of firing is recommended generally because it is quicker and safer. It is especially recommended for large stumps or blind stumps (top-rotted) because it permits firing at the same time the several charges distributed around the stump.

Tools.—A 4-ft. driving iron made of 1½ in. octagonal tool steel and an 8- or 10-lb. double-faced hammer are the best all around tools for making holes under stumps. They save time and will make a hole in practicaly all soils.

The iron is easily pulled out of the ground by battering it on the sides a few times. If it should stick, a pole or a bar slipped through a short piece of chain half hitched around the iron will easily pry it out.

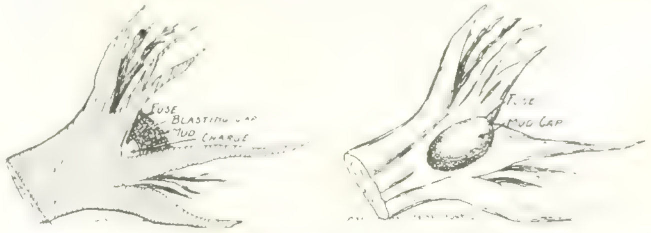
For holes deeper than 4 ft. the earth auger is best.

Proper loading of dynamite in bore holes is of vast importance. The paper cartridges should be slit with a sharp knife from end to end three or four times, then dropped to the bottom of the hole and crushed by firmly pressing with a wooden tamping stick. The cartridge containing the cap should not be slit at the primed end.

Tamping or confining the loaded charge is the biggest single factor in the success of stump blasting. Improper and careless tamping wastes dynamite, time, and money. Damp clay is the best material for tamping, but any soil used should be firmly tamped and made as firm as the surrounding soil. All pressure from the explosion escaping through an improperly tamped bore hole is wasted. About 4 in. of earth should be firmly pressed on top of the charge. Crumbled soil (not lumps) should then be rammed tightly with a wooden tamping stick all the way to the top of the hole.

The amount of dynamite required depends on several factors: the size, age, kind and condition of the stump, and the character and moisture of the soil. Table I shows the amounts of dynamite used to blow out completely white pine stumps under the conditions given.

Cracking Before or After Pulling.—To crack for a team pull, dynamite should be loaded in exactly the same manner it would be if intended to blow out the stump completely, and the charge should be reduced from three-quarters to two-thirds. To crack for a "block and line" the loading is done in the same way and the charge reduced about one-half. To crack before pulling with a stump puller, the loading is done in the same way and the charge reduced approximately one-third to one-quarter as much as for complete removal; to crack after pulling, the charge should be reduced to about one-fifth to one-sixth as much and should be loaded in either a natural crotch between the roots at the side of the stump or in the butt close to the crown. It is not necessary to bore in the wood. The dynamite should be placed close against the wood and thoroughly covered with plenty of mud.



Splitting With Dynamite After Blasting.

At the left is shown the placing of the charge in the butt of the stump—at the right, in a crotch at the side. Plenty of mud can be used for a cap. Electric blasting cap may be used instead of the cap and fuse.

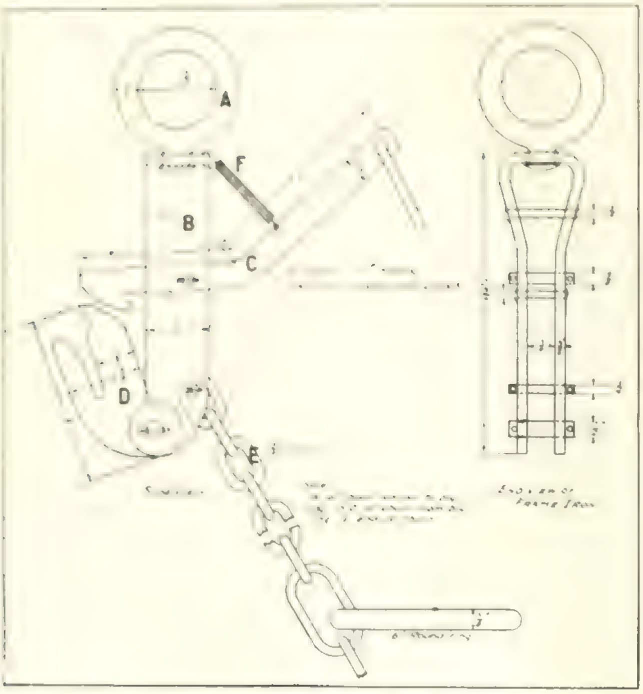
Grades of Dynamite.—It is rarely necessary to use a dynamite quicker than a 20 per cent grade. Except in loose sandy soil, 20 per cent dynamite will give exactly the same results as 40 per cent and 60 per cent, using pound for pound.

TABLE I. USE THE RIGHT AMOUNT OF DYNAMITE. THE AMOUNTS GIVEN IN THIS TABLE DID GOOD WORK.

At Hazen— [illegible] years old. [illegible] per cent dynamite. Silt loam soil.		At Washburn— [illegible] years old. 20 per cent dynamite. Superior red clay.		At Holcombe— 27 years old. 40 per cent dynamite. Sandy loam.	
Diameter, inches.	Load, pounds.	Diameter, inches.	Load, pounds.	Diameter, inches.	Load, pounds.
[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	14	[illegible]
[illegible]	4	14	[illegible]	[illegible]	[illegible]
[illegible]	5	16	1	15	[illegible]
[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]
[illegible]	4	[illegible]	1	[illegible]	
[illegible]	[illegible]	[illegible]	1	20	
28	[illegible]	20	1	[illegible]	4
[illegible]	[illegible]	[illegible]	[illegible]	21	[illegible]
[illegible]	[illegible]	22	2	21	4
	4	[illegible]	[illegible]	[illegible]	[illegible]
34	[illegible]	26	[illegible]	24	[illegible]
[illegible]	[illegible]	28	[illegible]	24	[illegible]
40	[illegible]	[illegible]	[illegible]	[illegible]	
40	[illegible]	30	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]		
	[illegible]	30	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]		
		30	4		
		[illegible]	[illegible]		

Capstan Puller.—Most of the horse power stump pullers on the market today are of a vertical type. A sweep from 12 to 14 ft. long turns the capstan. One end of a wire cable is wound on the drum and the other end is attached to the stump. It is called the pull line. Ordinarily the power of the team is multiplied by 10 to 40 but by the use of power pulleys the pulling power is multiplied indefinitely.

The smaller the drum the greater the power with the same length of sweep, but the harder it is on the cable because of the sharpness of the bend. A drum is full when it has a single layer wound on it from bottom to top. This is usually from 10 to 15 rounds or from 30 to 60 ft. of cable. To wind more than one layer on the drum cuts the cable.



Trip for Dropping Hammer.

To pull stumps near the puller with a pull line 150 ft. long and a drum that holds only 50 ft., a take-up attached to the line at the desired point gives the desired length of line. A 150-ft. pull line is an advantage because a bigger area can be stumped on a single anchor. An extension of 75 ft. on a 150-ft. line is common. The anchor cable is sometimes extended to increase the radius of the machine or to get a better place for it to work. A solid stump must be used for an anchor because it must be stronger than the stump to be pulled.

The cable is attached to the stump with a solid top by means of a choker. A cluster of three cables makes it possible for the men to put a choker on a second or a third stump while the first one is being pulled. Where the stumps are small the three stumps may be pulled at the same time. Stumps with decayed tops can be gripped only by a root hook.

The smallest crew to use with a stump puller is three men, one to drive the team and two men to handle the chokers or the hook. Two extra men, one to help the driver operate the machine and the other to handle one of the chokers or to prepare stumps for the hook, make progress somewhat faster, but the practice is questionable.

Good stump pullers are so made (1) that they are light and strong, and easily movable from place to place; (2) that they lock automatically against the back lash of the sweep in case something breaks; and (3) that they have a drum release to relieve the horses of pulling while crossing the cable. It is convenient but not necessary to have the machine equipped with a truck.

Here is the equipment needed for a capstan stump puller:

150 ft. of [illegible]-in. cable
75 ft. of [illegible]-in. cable for extension
[illegible] ft. of [illegible]-in. anchor cable
[illegible] ft. of [illegible]-in. cable for extending anchor
2 power pulleys
3 automatic take-ups (with choker on each).
1 root hook.
1 cluster of three chokers

Tripod Puller.—The tripod puller has been very popular in many cases, particularly where the roots are shallow and spread near the surface of the ground. It has plenty of power and does not require much cable, but has the disadvantage of requiring moving for every stump. The machine costs from $175 to $250.

One-man Puller.—The one-man stump puller develops a great pulling force at the sacrifice of speed. The machine is easily transported from place to place, and can be used conveniently in marshy places where a team could not operate. It costs from $50 to $200.

The Block and Line.—A simple pulley attached to the stump or snag to be pulled gives a team on a chain double power where the other end of the chain is anchored to another stump or snag. A ⅜-in. chain is commonly used. This seems to be the simplest power team-hitch on a stump too strong for a straight pull. It is commonly called the "block and line" method but should not be confused with the more complicated block and tackle which is too intricate for general practice.

Piling and Burning.—It is possible to pull large pine stumps whole, but in clay soils a great deal of earth clings to the roots. This leaves a large hole. The earth must be removed from the roots either by hand or blasting after pulling. Stumps shattered by dynamite before pulling are pulled in separate pieces and less earth sticks to the roots than when pulled whole. Furthermore, the stumps split in pieces are ready for piling and burning.

The stumps may be used for fuel but they are usually piled and burned on the ground. In either case the earth must be removed from the roots. It belongs back in the stump hole.

The high narrow pile burns better than one more spread out. The gin pole with a team, line and pulley is a simple, helpful device. Even with careful piling the stumps must be repiled to burn completely. Logs and stumps burn best when piled separately.

Movable pilers of various types are in use. A "home made" piler that has been used successfully in Wisconsin is known as the Conrath. The iron parts for the machine can be purchased from stump puller manufacturers or made by blacksmiths for about $60. This includes 150 ft. of ½-in. and 100 ft. of ⅜-in. cable. The owner can cut the timbers for the piler. The swinging boom is about 30 ft. long with a sheave at the end of it. From this sheave is suspended a single block to give a team double power in lifting the stump to

TABLE II.—STUMPING RECORDS MADE BY THE CREWS AT THE DEMONSTRATIONS CONDUCTED BY THE COLLEGE OF AGRICULTURE OF THE UNIVERSITY OF WISCONSIN AND CO-OPERATORS IN 1917.

Place.	Soil.	Description of stumps Kind	Age, years.	Diam., inches.	Height.	No. per acre.	Dynamite and labor per acre Dynamite Pounds	Per cent.	Caps.	Blasting hours.	Pulling hours. Men.	Teams.	Piling hours. Men.	Teams.
[illegible]	[illegible]	Wh. pine	25	14.3	22	101	38	20	71	20	29	10	23	14
[illegible]	[illegible]	Wh. pine	25	12.6	22	53	64	20	59	9	.		16	5
[illegible]	[illegible]	Wh. pine	30	16.5	38	106	45	40	27	9	32	12	29	13
Holcombe¹	Sand loam	Wh. pine	[illegible]	19.4	38	104	[illegible]	40	172	58	.	.	50	26
[illegible]	[illegible]	Wh. pine	41	22.0	28	120	[illegible]	30	47	7	31	11	14	6
[illegible]	[illegible]	Wh. pine	[illegible]	26.1	28	69	40	20	42	8	32	8	28	11
[illegible]	[illegible]	Wh. pine	30	24.7	34	42	44	20	45	[illegible]	30	..	⁵	
[illegible]	[illegible]	Wh. pine	[illegible]	22.5	28	76	127	20	95	27	.	.	26	11
[illegible]	[illegible]	[illegible]	21	9.6	[illegible]	163	9	20	6	½	24	6	11	3
[illegible]	[illegible]	Wh. pine	25	12.0	30	81	3	20	3	¼	12	3	6	3
[illegible]	[illegible]	Wh. pine	[illegible]	36.1	44	53	68	20	52	[illegible]	47	..	⁵	[illegible]
[illegible]	[illegible]	Wh. pine	38	28.6	44	39	141	30	114	55	.	.	17	7
[illegible]	[illegible]	[illegible]	[illegible]	12.9	18	108	5	20	9	1	29	10	15	8
[illegible]	[illegible]	[illegible]	[illegible]	13.1	20	116	139	30	144	47	.	..	26	9
[illegible]	[illegible]	[illegible]	[illegible]	13.0	20	118	13	20	17	1	23	6	13	6

[1] Cracked with dynamite before pulling with a capstan puller. [2] Pulled whole with a capstan puller and then cracked with dynamite. [3] [illegible] with a one-man puller. [4] Dynamite used alone to remove stump completely. [5] No record. [6] Included under pulling. The records of the work at Joel, Frederic and Laona are not reported in this table because they are incomplete. [illegible] stumps were decayed enough to be pulled without a hook or choker. This accounts for low cost.

the end of the boom. The pull of the horses then swings the boom until the stump is over the pile when it is dropped. A team or one good horse can usually lift the stumps as fast as two teams can drag them to the piler. Small pieces of stumps may be hauled on a stone boat and thrown on the pile by hand. For the smaller hardwood stumps a piler is less essential than for the larger pine stumps.

Dropping stumps on the burning pile keeps it stirred up and aids the burning. For this practice a particularly long boom is necessary. Even then, it is too hot for men to work with comfort near the burning pile and a sudden change in the direction of the wind places the piler in danger of burning.

The trip for dropping the stump at the right time is an important part of the piler. Such a trip is shown in the cut 22. It can be made by a blacksmith or a similar one can be purchased from a stump puller company for about $5. A hook has been provided at the end of the cable to drop the stump by releasing the horses when the trip refuses to work.

The trip is composed of six parts. B is the body of the trip and parts D, E and C are held into place by three bolts respectively. D is the lip which engages the trip arm C and is held fast by the spring F. A is a swivel eye by which the trip is suspended from the boom. E is a 5/16 in. chain 9/5 in. long with a large ring placed 10 in. from the trip. The operation of the trip is as follows: That part of the chain which extends beyond the large ring (or a circular hook with a narrow opening) is placed around the stump, drawn tightly, the end brought through the large ring and hooked up snugly into the lip, D. The 18 in. of chain between the ring, and the trip is called the tag chain. Its purpose is merely to keep the choker chain attached to the trip where the choker chain is not engaged in the lip. Now as the stump is hoisted over the pile a sharp pull on the rope attached to the end of the trip arm C disengages the lip D which in turn releases the end of the chain and the stump falls on the pile. A 30-ft. trip rope is attached to the arm C so that a release may be made at any time.

Stumping.—The stump is the unit of cost. The cost of stumping can be estimated intelligently only after the stumps on a test acre have been counted and examined. The condition of the stump and the nature of the soil are factors. Wide spreading, shallow-rooted pine stumps are removed much more easily than the deeper-rooted stumps. A top-rotted hardwood stump with sprouts is frequently harder to remove than a green stump.

The data given in Table II were obtained by the stumping crew of the College of Agriculture during the investigations and demonstrations of 1917. One man of the crew was available at all times to record the time and cost of each operation.

The average diameter of white pin stumps in Wisconsin is about 22 in. This was the average diameter of the 120. stumps on an acre of the demonstration plot at Phipps. (See Table II). The 120 stumps were cracked in the ground with 47 pounds of dynamite. It required 52 hours of man labor and 17 hours of team labor to crack with dynamite, pull with a capstan puller, and pile with a Conrath piler. Assuming that the stumping added $50 an acre to the value of the land, the returns for the labor expended amounted to about 60 ct. an hour.

To illustrate the method of using Table II the cost per stump for the three methods used at Washburn is taken for an example:

Assuming wholesale prices for dynamite and 20 ct. an hour for the cost of man labor and the same for team labor, the cost per stump is: Pulled whole with a capstan puller and then cracked with dynamite—the pulling and cracking cost 26 ct. and the piling cost 11 ct., total 37 ct. per 26.4 in. stump. Removed completely with dynamite—the removal cost 42 ct. and piling ct., total 52 ct. per 22.5 in. stump. No record was made for the cost of piling the stumps pulled by a one-man puller, but the total was about 45 ct. a stump.

These results tend to show that to pull with a horse puller and then to crack with dynamite is the best of the three methods tried. Had the method of cracking first and then pulling with a capstan puller been tried, it might have proved more efficient than any of the other methods. At the demonstrations it was impossible to try this method. One interesting fact is that it cost 35 ct. a stump to crack with dynamite and pull with a one-man puller, while it cost but 26 ct. a stump to pull whole with a horse capstan puller and to crack with dynamite, the stumps averaging about the same diameter.

A New Method of Preserving Railway Ties

A few years ago Mr. Geo. W. McMullen of Picton, Ont., in making various experiments involving modern bacteriology and practical chemistry, developed an entirely new process of drying timber, especially with reference to railway ties. Mr. H. K. Wicksteed, chief locating engineer of the Canadian National Railways in a recent article in The Canadian Engineer, describes at some length certain of these experiments and how the drying process is used with a subsequent waterproofing to greatly lengthen the life of a tie. What follows is drawn chiefly from this article.

Bacterial growth requires moisture and oxygen for its development. It would appear, therefore, that if we thoroughly dry a piece of timber, and keep it dry, it will last indefinitely. We know from actual experience that this is so. Everyone has used or seen old timber in the form of beams and joists taken from buildings two or three centuries old and perfectly sound. In these cases moisture has been excluded. Again, every one has seen, or at any rate read, of piles and foundation timber many centuries old in a perfect state of preservation. In these cases oxygen has been excluded. We all know that exposed timber will generally last longer when coated with paint or tar or some waterproofing material. The exceptions are where the timber has been waterproofed before it was seasoned, with the effect of retaining the moisture already in the stick and preventing its evaporation. Timber, even when air-dried for a considerable length of time, still contains 15 per cent or more of moisture, the percentage varying with the nature of the material and the size of the stick.

Another point not so well recognized or understood is that seasoning timber increases its strength by as much as 80 to 100 per cent in some cases over that of the green stick. It will be seen at once that, consistent with reasonable expense any loss of time, it is well worth while to dry not only ties, but timber of any kind used as a beam or strut, where strength is necessary. If we increase the strength by even 60 per cent, we require only 62 per cent of the amount of material, and, as this percentage is dry, while the other contains a very large amount of moisture, the saving in freight is very much more than the apparent 38 per cent.

It being granted that drying or seasoning is extremely desirable, the question is as to the means. In the case of ordinary lumber, air-drying supplemented by a few hours in a kiln is fairly satisfactory. In that of dimension timber this is not so. First, because the air-drying in the case of large sticks takes years to accomplish, because the temperatures used in the ordinary kiln are so high as to injure the strength of the timber; third, because, even when carried on with the greatest care and deliberation, the outside laminae dry first and shrink before the heart of the stick has any chance, and this shrinkage causes checks and cracks which, for many purposes, render the stick useless.

In early English practice the seasoning of large sticks was carried on by immersion in sea water for a period of 3 years, more or less, the saps and resins were dissolved and washed out, and the pores of the wood left open and filled only by water. The subsequent drying was then easily, quickly and uniformly carried on throughout the stick, and the resultant deposit of salt acted as antiseptics just as the creosote does in the modern process. This was perhaps the most perfect seasoning possible, or ever accomplished.

In experiments made in the last 2 years involving an entirely new process of drying timber an effort was made to use the same process that nature does, and dissolve, neutralize or wash out the sap and other liquids or semi-liquids which obstruct and close the pores, and to do this within a reasonable time, much faster than nature unassisted can accomplish the work. Hot water is more effective than cold water, and hot vapor of water is, in some cases, still more so. In the new process, which is simplicity itself in theory, although the best form of mechanical application took much time and thought to study out, warm vapor, or in other words, warm air, saturated with moisture, is circulated among the ties. The liquid components of the saps and resins filling the vesicles themselves, expand with the heat and force their way out, to be diluted and carried away by the warm vapor. After some hours of this treatment, the amount of moisture is reduced by very slow degrees, until, [illegible] the timber is removed [illegible] per cent of moisture left in it. The [illegible] depends upon the use of [illegible] as it does in [illegible] been found which did [illegible] care is taken not to let [illegible] above 160° F., so that no in- [illegible]

[illegible] way is indestruct- [illegible] and even with [illegible] long outlast un- [illegible] it is of course well suited to receive the creosote treatment, but instead of this expensive treatment a waterproofing coating costing much [illegible]

[illegible] oil tar was found which is an almost worthless by-product of refineries. The ties were merely dipped in a hot bath of this material for [illegible] sanded by a sand [illegible] and make them [illegible]

[illegible] ties it was concluded that the asphaltic waterproofings were imperfect because, under a strong hot sun, they melted and ran, and [illegible] case of ties, the waterproofing was gone. Some of the more tarry or pitchy products which penetrated the grain of the wood proved to be much better.

The cost of this process is estimated to be about 30 ct. per tie. One of the principal items of cost is the fuel for [illegible]

The ties now under test have been over 3 years in service. [illegible] in weight about 2½ per cent. The next tie, taken out after 14 months, had been treated with asphalt. It had increased 13 per cent, while two pitch-treated ties taken out at the same time had increased 1½ per cent and 7 per cent. This last was a spruce tie. When in for two years two pitch-treated ties had increased 7½ per cent and 2.9 per cent, while a couple of asphalt-treated ties had increased 14 per cent and 16 per cent, showing the difference in the two treatments.

In November, 1917, one pitch-treated tie had gone up 7 per cent and another 17 per cent, but in this last case there had been a strip of bark left on one side of the tie, which allowed it to become exposed. In May, 1918, one had increased 12 per cent, one 5 per cent and one 10 per cent. In our kiln dried ties the moisture is down to 5 to 8 per cent, so that apparently we have, up to the present, kept most of the ties down below 15 per cent moisture, which we figure is required to even start bacterial action.

The prospect which is opened up by this process is something more than merely getting the equivalent of the creosoted tie at a less cost. It is, besides, the potentiality of using for ties timbers which are now useless for the purpose, or nearly so. The northern birch, for instance, is a strong reliable wood, used by the Indians for every purpose requiring a hard wood, but unavailable for ties or bridge timbers on account of its superabundant sap and its consequent tendency to rot rapidly. The poplar and balsam are others for which there is at present practically no demand. These timbers are particularly interesting to us just now on account of the recent opening up by the railways of thousands of square miles of northern forests, of which, with spruce and jack pine, these are the main constituents. The use of these woods for commercial purposes means millions of dollars to the railways in reduced cost of ties and in freight.

The treatment of birch is considered as of special economic value because in Northern Ontario and Quebec it is the only native hardwood.

Living Costs Increase 70 Per Cent in 4 Years.—Living costs of wage earners increased approximately 70 per cent between July, 1914, and November, 1918, according to a Research Report of the National Industrial Conference Board. The average advances during this period in the various items of the family budget were: Food, 83 per cent; shelter, 20 per cent; clothing, 93 per cent; fuel, heat and light, 55 per cent and sundries 55 per cent.

A Motor Truck Is Only As Efficient As Its Body*

Two years ago a large eastern contractor invested $75,000 in motor equipment and put it to work in general contract operation.

Within little more than a year all this equipment was worn out. Some of it had to be scrapped and the rest sold at junk figures. That contractor is today strongly prejudiced against motor equipment, as compared with other machinery used in his business. He rents motor trucks, but will not invest in further equipment of his own, having gone back to horse hauling.

This experience led to an investigation, by transportation engineers, of the contracting field.

The purpose in view was twofold:

First, to learn who was to blame for such unfavorable results with motor equipment—contractor or manufacturer.

Second, to secure information upon which to more closely develop real motor transport for contract conditions.

It was found that both the contractor and the motor industry were to blame.

Motor Equipment Must Be Adapted to Particular Conditions. Contract hauling presents operating conditions which are both severe and diversified. Nothing but the very best motor equipment must be adapted to the particular conditions, both as to chassis and body.

"Hustle!" is the contractor's succinct motto. His projects must be completed by a definite date, with a money penalty for delay. So he pushes his organization and equipment to the limit. This usually results in overloading motor trucks, as well as working them too many hours a day, with inadequate inspection and repair. Speed limits are often exceeded, and trucks are driven over soft ground and rough roads.

But the motor industry has really helped contractors wear out equipment through neglect in studying conditions, and providing suitable chassis and bodies. Where large trucks of 5 to 8 tons capacity can be used upon fairly good roads, there is decided economy over smaller trucks, for hauling costs decrease in ratio with the size of the truck drivers' wages. Gasoline, tires, maintenance and repairs are not much greater for the large truck as compared with the small, and therefore greatly decrease the cost per ton-mile of material moved. But where soft ground and dirt roads have to be covered in contract work, the smaller truck must often be specified.

Bodies and Truck Life.—Unsuitable bodies are responsible for short truck life, and hauling difficulties. In some cases the motor truck industry sells the contractor a chassis, leaving him to supply the body. This frequently results in his providing a body capable of 40 per cent overload, which quickly wears out the equipment. In other cases where manufacturers supply the body, they do not adapt it to contracting conditions.

One very common type of body provided for contract services is the steel dump body, capable of holding several tons of dirt, rock, sand, gravel, coal, cement and like materials. The dumping is accomplished by a hydraulic hoist, operated by power from the motor, situated between the body and the driver's cab. To the eye of the designer of motor equipment this style of body probably seems to cover a wide range of services, but a careful investigation of motor equipment operating under actual contract conditions in territory around New York demonstrates that it is far from adequate, lacking flexibility.

For example, contractors often find it necessary to haul bags of cement and like material which cannot be conveniently loaded on the dump body. The latter has fixed sides, of inconvenient shape and perhaps too shallow for the piling of a full load of bulky material. Therefore, a body with removable sides facilitates loading and unloading. And a body of this type must be more strongly constructed than one with fixed sides.

The contractor often uses his motor equipment to haul snow, ashes, garbage, and other bulky material. For such work the hopper body does not give sufficient capacity, and attachable sides of extra height are desirable.

The hopper body is thoroughly unsuited to hauling lumber, reinforcing rods, and similar lengthy building material. So a body equipped with hinged tail gate, dropping down flat, and giving an extension at the rear, is more convenient. Such a tail gate hinged at the bottom permits loading long material, while hinged at the top it is a convenient automatic dumping device for sand, gravel, coal, etc.

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*Copyright 1919 by Transportation Engineering Department, Packard Motor Car Co.

Accessory Equipment that Facilitates Motor Truck Operation.—Contractors' motor equipment must be operated in all sorts of weather. Therefore, an enclosed driver's cab on the lines of the locomotive cab, instead of the simple seat with narrow roof and only the protection of flimsy curtains at the sides, makes the driver's work more efficient.

Contractors' trucks must often be hauled out of excavations and used for towing trailers. Strong towing hooks in front, with a guard for the radiator, do away with the necessity for attaching cables and ropes to axles, consuming time and frequently causing damage, while a trailer drawbar behind, of army type, permits the attaching of trailers, scrapers and other auxiliaries with least loss of time and the least possible strain.

Recently a transportation engineering study was made of the motor equipment used by a large coal company in an eastern city. This concern had trucks of three different capacities, ranging from 1 ton to 6 tons, with about half the units of 2 and 3 tons size. Detailed study of service performed and costs during a week, with transportation engineers riding over the routes on the trucks, and checking up losses of time in loading and unloading, demonstrated that practically all the trucks of 2 and 3-ton capacity were unprofitable. That is, this coal company had use only for its lightest and heaviest trucks, to take care of two kinds of deliveries, and its medium weight trucks were ill adapted for either light or heavy service, and therefore unprofitable.

Special Truck Bodies for Special Service.—Motor equipment is most profitable when actually running the greatest number of hours during its working day. Running time is governed by ease and quickness of loading and unloading. Loading facilities are a matter of closely adapting the body to the particular kind of materials handled, and there is a very wide range for the designing of special bodies for special service. In too many cases the purchaser of motor equipment has been left to select a type of body that seems, to him, adapted to his business. Very often his selection has been based on previous experience with horse equipment, and, therefore, failed to take into account the greater capacity of motor trucks over horse vehicles. Again, his selection has been made from the comparatively narrow viewpoint of his own hauling conditions, whereas a wide survey of conditions in his line of business, covering many concerns and localities, would have suggested improvements in body design which he could not have specified himself.

As an illustration of this, take a recent improved motor truck body for general service in interstate freight hauling. Freight and express service by motor truck came as a sudden war demand. Equipment of every conceivable type was hurried into use for the transport of merchandise, machinery, materials and farm products. In some cases bulky loads could be hauled unbroken from receiving point to destination. In other cases many diversified shipments had to be loaded and unloaded along the route. Sometimes the truck could be backed up to a loading platform and goods handled in the rear, but in other localities side-door loading would be more convenient. Shipments loaded in the front of the truck might be buried under shipments put in later at the rear, and were, therefore got at only with difficulty and loss of time.

To provide a special body with doors for loading at the sides as well as the rear seemed a very logical and natural adaptation of the motor truck body to such special needs. Yet this has only been done lately, and is an example of the need for intelligent adaptation of the motor truck body to a particular service.

Broader Field for Motor Truck Haulage Requires New Concepts.—The first railway carriages in England were family horse coaches fitted with flanged wheels, each embodying its owner's conception of traveling comfort. Within a very short period, of course, the greatest speed, power and capacity of the railway locomotive, as contrasted with horses, led to the building of larger coaches on standard lines to utilize the railroad's better facilities.

Some of the first railways in the United States were constructed in the belief that they would be used like highways, and any citizen who wished to fit a freight wagon with flanged wheels and put it on the rails, hauling by horses or mules, had that privilege. But, again, the broader view brought by greater transportation facilities, quickly developed the freight car with its larger capacity.

Practically the same transformation is again taking place with motor equipment for highway hauling. The greater speed, length of haul, and capacity made possible by motor trucks, necessitates entirely new concepts and designs. In one line of business there will be demand for equipment to haul bulky loads of large capacity without stops, while in another line the requirements are for light loads and frequent stops and flexibility. Thus far the tendency has been to merely supply motor trucks in various sizes and bodies, neither the manufacturer nor the purchaser having a clear conception of the service, conditions, or the lines of growth along which service would develop. But today broad knowledge of service requirements in different lines is becoming available, and real motor transportation begins to supplant the motor truck.

A motor truck is only as efficient as its body.

Motor manufacturers naturally centered most of their attention upon the chassis during the development of the industry. The problems of power, strength, weight, cost, tires and like factors were concentrated in the chassis, which had to be dealt with before there could be motor trucks at all. Having met his customer's demands for capacity and price, the motor truck manufacturer often left the matter of body to the customer's own views. Frequently the chassis was sold without body. In other cases general service bodies were added to the vehicle, modeled on types which had been found suitable with horse equipment. Where special bodies were designed, sincere efforts were made to meet the requirements, as with the steel hopper type for contract hauling, but such special bodies were usually designed without broad transportation engineering investigation of the work to be performed.

It is now clearly recognized that a wide field of development lies in the design of standard bodies for different industries and purposes. Purchasers of motor equipment in a given field are seldom in position to design bodies adapted to their own requirements, much less to profit by knowledge of other concerns in other fields, or to get the national view of what is best for their purpose. This is properly the function of the motor car manufacturer, and the problems must be solved by broad studies made by transportation engineers.

Cost Plus Contracts in Railway Construction

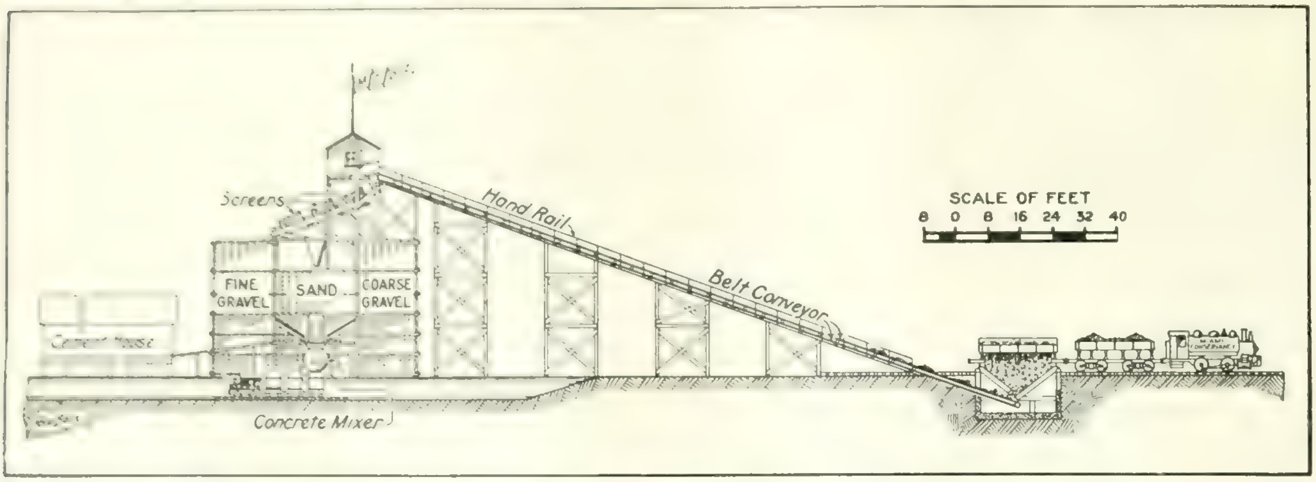
The "cost-plus" form of contract was in many ways a desirable instrument for the award of railway construction work under the uncertainties of war times. Inability to predict basic costs even a short time in advance made the unit price or lump sum contract undesirable, since the bidders had to make their tenders high enough to cover the maximum unfavorable conditions and the highest possible cost of materials and labor. Now, during the period of readjustment, conditions are subject to nearly as much uncertainty as during the war. Owing to the apparent failure of the price stabilizing plans and the fact that the prices of certain classes of labor are still subject to the laws of supply and demand, no one can predict with any accuracy what work will cost two months hence. Therefore, the form of agreement which will protect the contractor against rising costs, yet will allow the owner to take advantage of any reductions in the prices of materials and labor, would seem highly desirable from many aspects. The one basic objection to this arrangement lies in the lack of incentive for efficiency under the cost-plus contract. One contractor doing work on a unit price basis is now paying as low as 30 ct. for common labor, thus obtaining a neat margin over a bid made last fall under much less favorable circumstances. The question arises whether he would have taken the trouble to secure labor at this low rate if it had not been to his pecuniary advantage to do so. However, even this objection would not seem to justify the use of the unit price or lump sum forms of contract under present conditions for any except the small jobs to be undertaken immediately and completed within a few weeks' time. Work of this kind does not involve the uncertainties inherent in the larger projects of railway construction.—**Railway Age.**

Compact Gravel Washing and Concrete Mixing Plant of Miami Conservancy District

Concrete mixing plants combined with the gravel washing and screening plants are [illegible] for the Miami Conservancy District [illegible] the construction of dams for the district. The arrangement of this compact and effective combination is shown in the accompanying drawing, reproduced from the Miami Conservancy Bulletin.

Gravel is brought from the [illegible] pit by a construction train and dumped into a hopper. The material travels from the bottom of the hopper on a belt conveyor up the incline. At the top of the incline the gravel falls into a feeding hopper and passes successively through the screens. These screens, three in number, are of ⅜, 1½ and 3 in. mesh, the coarsest being at the top. Stones greater than 3 in. in size are carried by a chute to a car on the other side of the washing plant. The 1½-in. to 3-in. gravel goes to the coarse gravel bin. The ⅜-in. to 1½-in. gravel goes to the fine gravel bin. Material less than ⅜ in. in size goes to the sand bin. Strong jets of water wash dirt and other impurities from the gravel as it passes through the screens. The waste water and dirt are carried away down a discharge trough to one side. The concrete mixer is just below the sand bin. Chutes carry the material from the fine and coarse gravel and sand bins to the mixer, measuring boxes being built into the chutes, enabling correct proportions to be obtained. These measuring boxes permit adjustment for variable proportions. The cement is wheeled from the cement house up a slight incline to the mixer. The mixer discharges into 1¼-yd. steel concrete dump cars, which are hauled by a 3-ton, 3-ft. gage, gasoline dinkey.

The plant has a maximum capacity of 300 cu. yd. of concrete. The total length of the cement house is 100 ft.; of the gravel washer, including the gravel hopper, 215 ft. The total height of the structure, to the top, is 64 ft. The length of the 20-in. conveyor belt is 360 ft. The gravel plants were designed by Raymond W. [illegible]



Gravel Washing and Screening and Concrete Mixing Plant of the Miami Conservancy District.

Railroads of the Future.—At a recent meeting of the committee appointed by the Investment Bankers' Association to draw up a plan for the return of the railroads to private management, the suggestion was made that the various lines be amalgamated into a few large systems. It was held that by such a consolidation the benefits of centralized control could be obtained without destroying the kind of competition that would be of advantage to both the railroads and the public. It was also held that the Government ought to guarantee a return upon the capital invested in the railroads until the readjustment to the new conditions has been accomplished. The consolidations proposed under this plan differ from others that have been suggested in that they would follow natural rather than arbitrary lines. They take cognizance of the historical development of the present systems, which has been continental rather than regional. The plan contemplates the continuance of Government su- [illegible]

Some Observations on Rail Failures

Dr. P. H. Dudley, Consulting Engineer, New York Central Lines, the well known expert on rail, has contributed a discussion of the paper on this subject by Mr. Geo. F. Comstock, which was presented at the February meeting of the American Institute of Mining and Metallurgical Engineers.

The subject of rail failures, their causes, and the influence of minor changes in the process of manufacture, have for some years received the most careful investigation by Dr. Dudley and other experts and the railroads are beginning to reap the benefits of these painstaking studies. From the April bulletin of the above organization we have abstracted the following from Dr. Dudley's discussion:

When the mills for the manufacture of Bessemer steel rails were first installed in the United States, the blooms were reheated before the rails were rolled. John Fritz and Alexander Holly always constructed furnaces for reheating the blooms in the mills. They knew by intuition and experience that the steel rails would have greater ductility to withstand breakages in service. They tested the steel of each Bessemer heat by the simple method of bending, to fracture around the horn of an anvil, a forged or rolled bar ⅜ by ⅝ in., from the test ingot. The texture of the fracture of the steel bar was examined with the same scrutiny and care as crucible tool steel, for at the inception of the manufacture of Bessemer steel rails, they did not have chemists to make an analysis of the steel. The first manufacturers, therefore, were obliged to judge the requisite properties of the steel for rails by the bending tests, fractures of the small bars, and small test ingots. Drop tests on the rails were installed in a few years after the construction of the mills.

All of the early Bessemer steel-rail manufacturers retained the practice of reheating the blooms. One Bessemer mill was constructed, when the output of this grade of steel was less than the demand, without this furnace, in order to reduce the time and cost of manufacture. The reheating furnace was also omitted in some subsequent mills, but these reheating furnaces would not have been omitted in the designs of the plants had the constructing officials understood that the quality of the output would be affected in an occasional rail-head. Their value is now being recognized and reheating furnaces will doubtless be installed, in a short time, in all basic open-hearth mills that did not include them in their original construction.

The service records of 8 heavy-traffic railroads show that of 882,237 tons of rails that failed from interior transverse fissures 559,644 tons were rolled direct, developing 1,054 interior transverse fissures. Of 322,593 tons from reheated blooms, only 59 developed interior transverse fissures and nearly one-half of these failures were from rails rolled when the mill was being equipped for reheating the blooms. Some of the other failures were from rolling of rails when reheating of the blooms was under difficulties not common to the regular mill practice for such work. These rails were rolled at 11 different mills in and between the years 1909 and 1915, while the record of failures includes those that developed up to Oct. 1, 1918.

One mill that reheats the blooms has produced, in the past 12 years or more, a large output of basic open-hearth rails in which up to Jan. 1, 1919, Dr. Dudley had not been able to find, from the different railroad companies using the rails, that a single interior transverse fissure has occurred in the rail-heads. Another mill, with not as large an output, has the record of only one interior transverse fissure.

Dr. Dudley's investigations show that interior transverse fissures in rail-heads are induced by a combination of two or more exceptional conditions of manufacture in an occasional rail-head principally by direct rolling, which can be practically eliminated by reheating the blooms.

The first contributory cause may be the segregation of the setting ingots, delayed transformations of the steel near the center of the head, chemical and mechanical defects. The first effect is induced loss of strength, initial stresses, a non-ductile core of physically heterogeneous metal in the interior of the head, with an occasional zone of enlarged grain growth.

The second contributory cause may be mechanical injury to the physically heterogeneous metal. Either the nucleus in the rail-head is checked transversely by the gag, when it is applied on the base of a low rail or the imprint of the gag is checked longitudinally when applied.

The third effect is that the broken area of interior metal in either type is no longer able to restrict either the pressure or the stresses of the wheel loads, as the case may be, within the usual range of elastic limits of the steel, as in sound metal, which is homogeneous.

The service records of Bessemer or basic open-hearth steel rails show that interior transverse fissures have not occurred in the countless thousands of rail-heads of physically homogeneous metal under the same wheel loads. The reason for their non-occurrence is that the rail-heads did not contain the conditions of the first contributory cause, consequently, while the metal is lengthened or shortened by the gag it was not checked. Three interior transverse fissures only have developed to date in basic open-hearth rails from the chemical composition prescribed by the New York Central Lines, specifications and rolled from reheated blooms.

It is a frequent occurrence in the mill that too heavy a blow is given by the gag on the head, and then the rail is turned base up for a light blow to correct the effect of the excessive blow on the head. When too heavy a blow of the gag is applied to the base of a low rail, it must be turned head up and given a light blow to reduce a part of the set of the heavy blow. Rails are sometimes completely fractured in the straightening press by the application of the blow from the gag. An interior core of brittle metal is the initial point of fracture in nearly every instance, and is found in the general location of the nuclei of interior transverse fissures.

Occasionally rails are heard to snap under the straightening press, in which case the interior non-ductile core of brittle metal is checked and broken, while the surrounding envelope of more ductile metal is elongated, or shortened as required, without injury, unless the applied blow is sufficient to rupture the entire rail section. Such rails would only be noticed and rejected by either the railroad or mill inspector when near the straightening press as the sound would be the only thing that would attract his attention.

Dr. Dudley refers to the disagreement between the Government investigators and the railroad experts and explains that the careful service records kept by the railroads disprove the theory advanced by the Government men that the interior transverse fissures are caused by fatigue fracture of the metal.

The Government investigators do not explain the origin, time, and place of occurrence of the nuclei, nor their variations in size from 0.0625 to 0.375 in. in diameter of the type of interior transverse fissures classified by me as intergranular. All fractures of this type show nuclei of considerable area, and not points, which is the common type in fatigue fractures. These areas, constituting the nuclei ruptures as units and not by slow detail, show positively and conclusively that fracture was caused by the application of a rapidly applied blow of a pressure beyond the elastic limit, or even ultimate strength, of this interior core of inferior metal.

The figures collected from the service records prove that rails rolled from reheated blooms rarely develop any interior transverse fissures, while they are abundant in rails that are rolled direct. One mill has introduced reheating furnaces for its output and since then there has been a radical reduction of failures of this type. The mills are now giving more attention to the hot-bed treatment and regularity of practice than was the case in the early days of the manufacture of basic open-hearth rails. Several of the plants have introduced straightening presses with 60-in. supports, which reduces the pressure upon the 105-lb. rail sections by 50,000 lb. to put a permanent set in the metal to straighten the rail, as compared to the pressure required in straightening this section on 42-in. supports.

The following conclusions are offered by Dr. Dudley:

The service records show that reheated blooms coupled with proper chemical composition and mill practice will practically eliminate interior transverse fissures in rail-heads of the occasional rail.

The service records show that investigations of the years past indicated the proper design and composition for the manufacture of rail sections in Bessemer and open-hearth steel, that have permitted on the same roadbed the driving wheels and their loads to be trebled and the car wheels and their loads to be quadrupled with large factors of safety in operation.

The service records show, by the general practice of the railroads, that the tensile stresses in the spacing of the wheel loads are so far below the elastic limits of the steel that the alternate stresses do not approximate those necessary for fatigue fractures of metal in the interior of the rail-heads.

The contours of the wheel treads should return to those in use when the designs of the rail sections were made which enabled the increase in wheel loads. This is required to distribute the wheel contact pressure and loads to a sufficient width metal in the bearing surface of the rail-head to hold the average intensity of pressure, practically constant in rail-heads of 3-in. width.

The law of the service records under the daily observation of the railroad officials is more reliable proof of the safety in transportation than an opinion that does not take cognizance of the facts.

Some Possibilities of Steam Railroad Electrification

In a recent paper, Mr. Calvert Townley, assistant to the president of the Westinghouse Electric & Manufacturing Co., makes some observations on the possibilities of steam railroad electrification as affecting future policies, which should prove of interest to railway engineers and operating officials. Some of the financial and economical phases of the electrification problem are very clearly stated by Mr. Townley as follows:

Electricity now performs every railroad service previously rendered exclusively by steam locomotives and in every case does it better than it was done before. But in order to use electricity a large investment in equipment and installation must be made and electrification has proceeded slowly because railroad executives were not convinced that the advantages to be gained are always worth the cost.

Electricity fills every requirement of railroad service, but as it involves a large investment, electrification has proceeded slowly. Electrification has also been retarded because the problem has been largely considered one of replacing the steam locomotive by the electric locomotive whereas in reality the problem is much broader. It really offers a fundamentally different method of train propulsion because the limitations of the steam locomotive disappear and the strictly limited motive power is replaced by one that is practically unlimited, thereby opening up many possibilities in the methods of railroad operation. While there are a number of different systems of electric traction all of the systems have many features in common and the possibility of unlimited power is a characteristic of them all.

Existing electrifications have been operated for a sufficient length of time so that operating statistics are now available, and any proposed undertaking may, therefore, be predicated on established facts. While electrification will greatly increase track capacity, there is a large railroad mileage which already has more than sufficient capacity, in which case electrification would not be justified. On the other hand, there are so many cases where its advantages are so clear and conclusive that when the railroads are able to finance [illegible] the capacity of the [illegible] to serve them.

The [illegible] is not simply the substi[illegible] for another. It is far more [illegible] fundamentally different [illegible]. It is conservative to say that, within the bounds of ordinary practice, electricity can furnish [illegible] power that can be used. [illegible] in this respect dis[illegible]. A strictly motive [illegible] practically unlimited.

[illegible] independent unit which not only generates but also utilizes its power. The electric locomotive generates no power at all. It is only a translating [illegible] side and a remote source. The electric power house always having much greater capacity than any one locomotive, can supply ample power for the heaviest train on the steepest grade. The steam locomotive [illegible] power house with it is limited to the capacity of its one boiler. By the multiple unit principle, as many electric locomotives as may be needed can be coupled together and operated in syncronism by one crew from any cab. Any required tractive effort can thus be exerted without slipping the wheels, without impos[illegible] on the rails or bridges and without increasing the number of engine crews.

Unlimited motive power permits longer trains and higher schedule speeds. On the Elkhorn grade of the Norfolk & Western R. R. the schedule speed was doubled. It cuts the operating cost by hauling more cars with the same or a smaller crew. The Norfolk & Western R. R. uses two electrics to do the work of three Mallets.

The traffic possibilities must be studied from a new angle and advantage taken of every facility. It is a new thought to realize that train length is limited not by motive power but by the yard tracks and length of sidings, or that all the trailing tonnage that the drawbars will stand can be hauled. Nor are these new limits fundamental. Sidings can be extended, drawbars can be made stronger, if it pays to do it. In a word, electrification opens up tremendous possibilities [illegible] the freight capacity of a road and without it being necessary to build additional tracks.

While not as important as freight, passenger traffic likewise comes in for its share in the widened horizon and the vanishing tradition. Unlimited power of course is available but the absence of combustion is another basic advantage. Smoke and cinders disappear. Tunnel operation loses its terrors. Unobscured signals permit normal speeds with undiminished safety. Projects like the Pennsylvania terminal in New York depending entirely on submarine tunnel operation and previously impracticable, become immediately possible. Railroads owning valuable realty in cities can erect buildings thereon, where before smoky locomotives made any structure above the ground level impracticable.

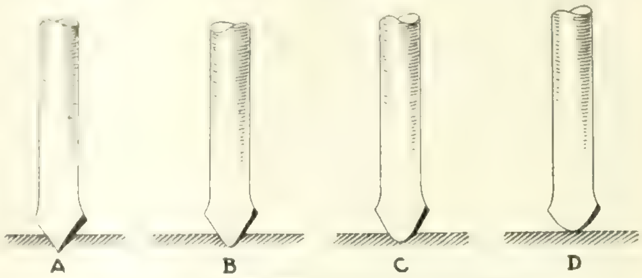
The service performed on the electrified sections comprised practically every kind of railroad transportation. The Bluefield division of the Norfolk & Western R. R. in West Virginia is an example of an important coal road operating through the mountains. The Chicago, Milwaukee & St. Paul 440-mile main line, through Idaho and Montana, demonstrates what can be done by a trans-continental carrier on a large scale with through traffic, both freight and passenger. The New York, New Haven & Hartford R. R. 73-mile stretch [illegible] New York and New Haven shows how through freight and a heavy passenger traffic can be taken care of on the most congested four-track section of an important eastern carrier and what is possible for complicated freight yard operation, while the New York Central R. R. and the Pennsylvania R. R. out of New York City are splendid examples of our greatest modern passenger terminal electrifications. There are of course many other electrifications, but even if there were not, those named are of a character to command the respect and attention of the railroad world. Every one of these projects has been successful. Every one has justified itself.

No general rule for electrification can be given. Generalities are sure to be misleading, but electrification is now firmly intrenched and successful. It is recognized by railroads generally as an effective agency with great possibilities and one which is particularly valuable for certain specific purposes. Time alone will tell how broad its application is to be.

The Blow of the Drill Bit, Sharp or Dull

The cutting action of dull and sharp drill steel is explained by Mr. Frank Richards in an excellent article in the Engineering and Mining Journal. In his article, which is reprinted below, Mr. Richards points out that the limit of permitted wear of drill bits should be sharply defined, and that the systematic maintenance of sharp bits is the most profitable investment possible in connection with rock cutting operations.

It is usually a source of satisfaction to bring theory and practice into co-ordination and to find them reciprocally confirming and strengthening each other. The method of computing the force of impact of a falling weight or of the blow struck by the ram of a steam hammer, is essentially simple, but the practical application is generally far from satisfactory, on account of the indeterminate value of one of the essential factors. The final result in each case indicates that the force of the blow struck may be great or little, according to the suddenness with which the propelled mass is arrested. It is possible, however, without making the final particular specific, to reach a practical determination which may be most convincing.



Sketch Representing Blow of Drill Bit.

A letter which has recently come into my hands seems to afford an excellent opportunity for a practical application of the principle involved in this line of investigation. The writer says: "At a drill test which is being carried out at a mine near here, and in which I am particularly interested, it has been stated that though the drill is effective, it is at the same time hard on the steels. I was, in fact, shown ten pieces of steel that had been broken in a day's run. I am not a steel expert, and in this case I did not need to be, for at a glance I noted that every piece of steel that had been broken had been used in the test entirely too long; that it had been used, in fact, after it had lost its cutting power. On some of the pieces the bit end was entirely flattened, and no cutting edge at all was left. Noticing this was entirely by accident on my part, but it worked out all right in the next day's drilling. As soon as the cuttings ceased to drop out of the hole, the steel was changed, and we never broke a single piece of steel. On one of the drills we used a dull piece of steel, and in less than two minutes the steel broke."

If the theory of the hammer blow be applied to this case, a sufficient explanation is obvious. The drill steels did precisely as they ought to have done under the circumstances; the dull steels "went on a strike" against any more work when in that condition.

The method of computing the force of the blow of a rock drill may perhaps be more simply and clearly illustrated in the case of a reciprocating piston drill, although the results noted, under the same conditions, would be identical in the case of a hammer drill, which is now more generally used. The unit usually assumed in stating or in computing the force of a blow is the foot-pound. Supposing the operation to be conducted with a rock drill with a piston 3 in. in diameter and a stroke of 6 in., and that in the working stroke of the piston it is driven the entire distance by an effective air pressure of 50 lb. per square inch. The area of the piston is almost 7 sq. in., and if the stroke of the piston were 1 ft. the accumulated force at the end of the stroke would be represented by $7 \times 50 \times 1 = 350$ foot-pounds. As the assumed stroke of piston is ½ ft., the resulting force would be only one-half of this, or $7 \times 50 \times \frac{1}{2} = 175$ foot-pounds. This number of foot-pounds of energy might have resulted from various other combinations of stroke and pressure, as, for instance, with a stroke of 1 ft. and a pressure of 25 lb., $7 \times 25 \times 1 = 175$ foot-pounds, or, with a stroke of 3 in. (¼ ft.)

and a pressure of 100 lb., 7 × 100 × ¼ = 175 foot-pounds. It is essential to get this fact clearly in mind, because in bringing the piston to rest, or in the striking of the blow, an opposing force or resistance is required precisely equal to the active force that was employed to produce the motion.

The resistance will, of course, be greater in proportion as the distance which the force is applied is shorter. Thus 50 lb. of resistance effective through 6 in. of stroke would be required to overcome the 175 foot-pounds of imparted energy, and 6 times this or 1,050 lb. would be required if stoppage was done within a distance of 1 in. For convenience this last figure may be called 1,000 lb. Then 4,000 lb. of resistance would be required to stop the movement within ¼ in. and 16,000 lb. or 8 tons, if the stoppage was done with 1/16 in.

This brings the computation to what may be assumed to be, approximately, rock-drill cutting conditions. If the drill but penetrates the rock, say, 1/16 in. at each blow, then 8 tons is applied, and, alternately, is stopped entirely, several hundred times a minute, and theoretical calculation here requires a constant or mean resistance of 8 tons for the entire 1/16 in. of penetration of the rock. The fact undoubtedly must be that the resistance will be much greater than this at the beginning of the penetration and that it will diminish to nothing at the instant the penetration ceases. If the penetration of the drill bit was only one-half of this, or 1/32 in., that is, if the bit was stopped within this distance, then the force of the blow struck by the bit would be double that noted, or 16 tons.

The bit strikes the rock with the same force as that with which the rock strikes the bit—the force must be precisely equal in each direction from the point of contact—and the greater the force at any instant with which the bit strikes the rock, the greater also must be the reacting force against the body of the bit.

The accompanying sketch, which represents, with perhaps slight exaggeration, the action of one wing of a sharp drill bit, and then in several stages of wear, may help to a clever understanding of the matter. At A, with the bit perfectly sharp, it is to be observed that it makes its deepest penetration into the rock. After coming in contact with the rock surface, it penetrates the rock a certain distance, during which penetration its force is expended upon the rock in one direction and backward into the body of the bit equally in the other direction.

It is here assumed, of course, that the drill bit receives at each stroke an equal impulse from the air which drives the drill. Note at B that the bit has been considerably worn or blunted, and that although it has the same force behind it which it had at A, when it first touches the rock, it does not penetrate the rock to the same depth, but is stopped within a shorter period of travel, and, consequently, the force involved in the stoppage must be greater for the shorter period, both upon the rock and back into the drill bit.

No computations could assist in realization of the evident fact that the force of the blow upon the rock, and reactively back into the body of the steel, is successively greater when the bit is worn, as seen at C and D. At D the penetration of the rock must be extremely minute and the shock upon the drill bit incalculably great. What could be expected of the steel under such conditions, or approaching such conditions, than that it should "give up the job" and break? The fact that breakage occurs when the bits are too much worn is an endorsement of the efficiency of the drill which applies the power, and demands an appreciation of the drill, instead of condemnation. A drill which does not break its bits when, on account of dullness, they ought to break, must be defective in some particular.

From the preceding it will be noted that the action of the drill bit when it wears presents a paradox. The bit is least effective, has the least penetrative results, blow for blow, when it strikes the rock the hardest and feels the shock the most. It is the sharp bit that does the work; the dull bit is the inefficient victim of mistaken or neglectful practice. Drills must wear, but the limit of permitted wear should be sharply defined, and the systematic maintenance of sharp bits should be recognized as the most profitable investment possible in connection with rock-cutting operations. Especially is the power-drill sharpener to be commended, not only for its incomparably greater efficiency, as compared with hand sharpening, but also for its promotion and maintenance of the sharp-drill habit of thought and practice.

Increasing Strength of Concrete by Rodding

Recent experiments conducted by the engineering division of the Bureau of Economic Geology and Technology of the University of Texas have resulted in the discovery that by the simple process of "rodding" the strength of concrete may be greatly increased. The following information regarding the experiments has been furnished by Mr. F. E. Giesseche, Head Division of Engineering, School of Architecture, University of Texas:

The term "rodding" signifies pushing a pointed iron rod into the soft concrete and working it up and down in order to compress the concrete and allow the "excess" water and the entrapped air in the concrete to escape upward.

The best results due to rodding were secured in the laboratory when the concrete was rodded at intervals of about 30 minutes until the concrete was too hard to permit further rodding; in one case this required about 7½ hours. Each specimen was worked only about 10 to 15 seconds at these intervals.

The idea of working the excess water out of concrete in order to increase the strength occurred to Mr. G. A. Parkinson, Assistant Testing Engineer, during the fall of 1917. A few tests were made at that time and gave very favorable results.

In June, 1918, a definite series of tests was begun which confirmed the earlier tests. The object of this series was to see how much the strength of "6-sack" wet concrete could be increased by rodding, how the increase of strength varied with the age of the concrete, what particular type of rodding was best, and if it was possible to overdue the rodding and injure the concrete thereby.

Forty-eight cylinders, 6 in. x 12 in., were prepared and tested at ages varying from 7 days to 3 months. The general conclusions from this series were that the strength of "6-sack" concrete mixed with 10 per cent of water, can be increased about 100 per cent by rodding. In these tests, the increase amounted at an age of 7 days to about 80 per cent (from 1,465 lb. to 2,690 lb.); at an age of 28 days, to about 120 per cent (from 1,962 lb. to 4,348 lb.); and, at an age of 3 months, to about 93 per cent (from 2,385 lb. to 4,612 lb.).

The effect of the rodding seems to depend on the number of times the specimens were rodded; in two cases the specimens were rodded about 12 times; in one case about every 30 minutes and in the other about every 20 minutes; the final strengths were about the same in both cases. In a third case the specimens were rodded every 30 minutes 15 times, and the final strength was about 10 per cent greater than in the two former cases.

It was not possible to overdo the rodding and injure the concrete thereby; in two of the cases cited above the concrete was rodded until it had set so firm that the rod would no longer penetrate it sufficiently to continue rodding. In the case where the greatest strength was secured (4,644 lb. at 28 days and 4,961 lb. at 3 months), the specimens were rodded every 30 minutes for 7½ hours.

In February, 1919, a second series of tests was begun in which concrete containing about 4, 6 and 8 sacks of cement per cubic yard of concrete was used, and in which the proportion of water varied from 7 to 10½ per cent; the minimum value was about as little as was practicable to use, and the maximum value was more than should ever be used in regular work where any attempt is made to secure good results.

The object of this series was to determine how the increase in strength due to rodding varies with the relative quantities of cement and the relative quantity of water.

One hundred and forty-four specimens were prepared, one-third of 3.8-sack concrete, one-third of 5.86-sack concrete, and one-third of 8.45-sack concrete; in each of the three types of concrete, one-fourth was mixed with 7 per cent, one-fourth with 8 per cent, one-fourth with 9 per cent, and one-fourth with 10 per cent of water, except for the 8.45 sack concrete, in which the percentage of water was increased one-half per cent.

One-half of the specimens were rodded a little and the other half were rodded 12 times, once every 20 to 30 minutes; each rodding required from 10 to 15 seconds for each specimen.

[illegible] shows that the [illegible] from about 7,900 to about [illegible]. This shows an increase of only [illegible] which is partly due to the fact that the [illegible] specimens received brought [illegible], which is very high for [illegible] of cement per cubic yard [illegible] is approximately to a 1:3:6 mix. For these proportions the Special Committee on [illegible] Concrete of the American Society [illegible] an ultimate strength of [illegible].

The following table shows the results of the tests in detail:

[illegible]	[illegible]	[illegible]	[illegible]	strength Plain	Bonded, lb.	Per cent increase
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	48.7
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	16.1
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Experience of Santa Fe System With Treated Ties

[illegible] the railways in America began to take notice [illegible] shortage of [illegible] ties and looked to Europe for information regarding timber treatment in order to prolong their life, it has become increasingly evident that, in spite of the greatly differing conditions on the two continents, it [illegible] pays to subject the cheaper, softer woods to a preservative treatment here in the United States.

It is one thing however, to be quite sure that a given thing or process is economical, and quite another to be able to say just how much the saving is; and in the matter of tie service in the track, the difficulty of getting reliable records kept was early recognized by the railway officials, because these records necessarily must originate with track foremen who do not always have the time or the ability to keep records properly. Indeed it has been a complaint of the section foreman frequently that too much of his time was taken up with clerical work.

Various schemes have been tried to check up the records kept, and with varying success. The excellent showing made [illegible] Santa Fe system on its lines east of Albuquerque, N. Mex., and north of Purcell, Okla., is summarized in a recent issue of the "Railway Maintenance Engineer," from which the following is abstracted:

For the 5-year period ending with 1901, the average number of ties inserted annually per mile of track was 259; and for the 5-year period ending with 1916, the number was 199, a decrease of 23 per cent. This is equivalent to a saving of 570,000 ties annually.

Since equivalent reductions have been effected on the Gulf and Coast lines of the system the total annual reduction in tie consumption on the entire system as a result of treatment and other protection of the timber will aggregate 1,000,000 ties annually.

This unusually long life is the result of close attention to all forms of timber protection, including treatment. The Santa Fe has been the pioneer in the treatment of ties in this country. Over 80 per cent of the ties in the parent lines and over 65 per cent of those on the entire system today are treated ties. The system has also been a pioneer in the use of screw spikes.

The [illegible] step to be taken in an effort to secure the maximum possible life from ties and other treated timber has been the systematic inspection by the treating department of the ties taken out of tracks. Beginning on May 15, 1918, timber inspectors on the staff of the manager of treating plants for the system were sent out to inspect ties taken out of tracks by the track forces. The latter are not required to hold these ties indefinitely, but the inspectors are instructed to examine all such old ties as they find along the right-of-way at the time of their visits.

Several objects are obtained by these inspections, although the fundamental one is to secure the maximum possible service from the treated ties. Therefore, the primary duty of the inspector is to ascertain if any ties are being removed from the track sooner than is necessary. Another object is to determine the ultimate cause of removal. This information has not been obtained satisfactorily in the past because of the habit of section foremen of reporting the cause in almost all cases as decay. Thus it is expected that the work of the inspectors will afford valuable information on the deterioration of ties through defects in the treatment, mechanical wear, improper handling or any other causes.

The inspectors were instructed from the start that this work was not to be conducted simply as a check on the maintenance forces, but rather in a spirit of co-operation or assistance, it being the idea that the full benefit of this system of inspection cannot be obtained unless hearty co-operation is obtained from the division forces. To this end the motor cars used by the inspectors are provided with an extra seat so that the roadmaster may make the trip over his subdivision with the inspector.

The roadmaster is advised in advance when to expect the inspector so that he may readily arrange to accompany him. With the roadmaster present the inspector can reach a better understanding regarding the ties inspected. Fundamentally this affords an intimate contact between the roadmasters and the timber-treating department, whereby the difficulties of each can be discussed.

A similar spirit of co-operation is maintained with respect to the division superintendents. Each superintendent is sent a copy of the inspector's daily report on his division, and he also receives copies of the monthly summaries of the daily reports of the work on his division, the monthly reports also being sent to the chief engineer, general superintendent and general manager. It is the plan to have these inspectors cover the entire system, working continuously. The inspections cover all timber bridge materials, both treated and untreated, as well as the track work.

In 1906 the Santa Fe commenced treating its ties with creosote by the Rueping process and continued this practice until compelled to return to zinc treatment in 1914, on account of war conditions, which made it impossible to secure creosote in sufficient quantities so that it could be used in treatment of ties.

Successful Track Standards on Chicago Street Railways

In 1907 a city ordinance was passed in Chicago creating a board of supervising engineers in connection with the rehabilitation of the street railways. This board, composed of competent engineers, at once began the study of improved standards for track construction, realizing that this subject was of the utmost importance. Many large cities were visited and studies made of various types of construction, and as a result five standard types were adopted, and since then have been built in varying amounts. These five types of construction are shown below. Early in the investigations it was discovered that a wood tie in good condition is greatly preserved when incased in concrete, and at the present time no wood ties for the Chicago railways are treated in any other way. The zinc-chloride process was tried but found to be unsatisfactory on account of the chemical galvanic action which very rapidly corroded and ate up the rail spikes.

As will be noticed in the illustration the granite block paving between the rails is generally standard. After some experimenting it has been found best to lay these blocks on a bed of dry mortar consisting of 1 part of Portland cement and 3 parts of torpedo sand, spread to a depth of 1½ in., then filling the joints with a wet grout. Enough water from this grout passes through to the cushion of dry mortar so that the latter sets up and holds firmly the paving blocks. This practice is in accord with modern practice in ordinary granite block sheet paving, and is considered the best means of providing a waterproof pavement.

As far as can be determined at present these types of track construction promise to give long life and good service, and in the 11 years since adoption no changes have been found necessary.

A recent issue of the "Electric Railway Journal," from which the illustrations and data in this article were largely taken, states that 92 per cent of the track in Chicago is of this standard construction, about 58 per cent being Type 2A, and about 27 per cent being Type 3.

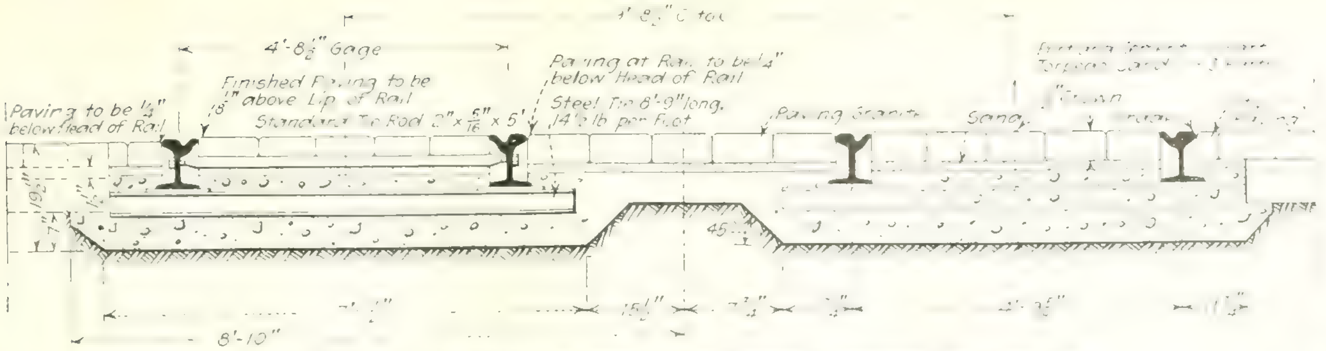

4'-8½" Gage
Finished Paving to be ⅛" above Lip of Rail
Paving at Rail to be ¼" below Head of Rail
Paving to be ¼" below Head of Rail
Standard Tie Rod 2" x 5/16" x 5'
Steel Tie 8'-9" long, 14½ lb per Foot
Paving Granite
Sand
Crown
Portland Cement
Torpedo Sand
19½"
7"
45°
15½"
8'-10"

Fig. 1—Type No. 1 of Chicago Standard Track: Concrete Foundation and Steel Ties

The Supervising Engineers on June [illegible], passed a resolution that all new track built thereafter, unless otherwise specifically ordered, shall be 10 ft. 2 in. center to center, and the dimensions of the above drawings changed accordingly. Outside rails to be ½ in. lower than inside rails.

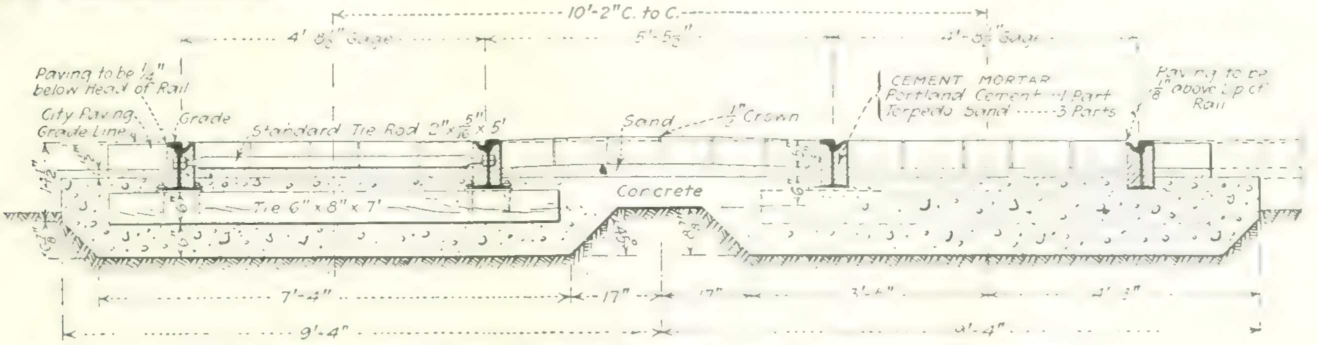


Fig. 2—Type 2A of Chicago Standard Track: Concrete Foundation and Wood Ties

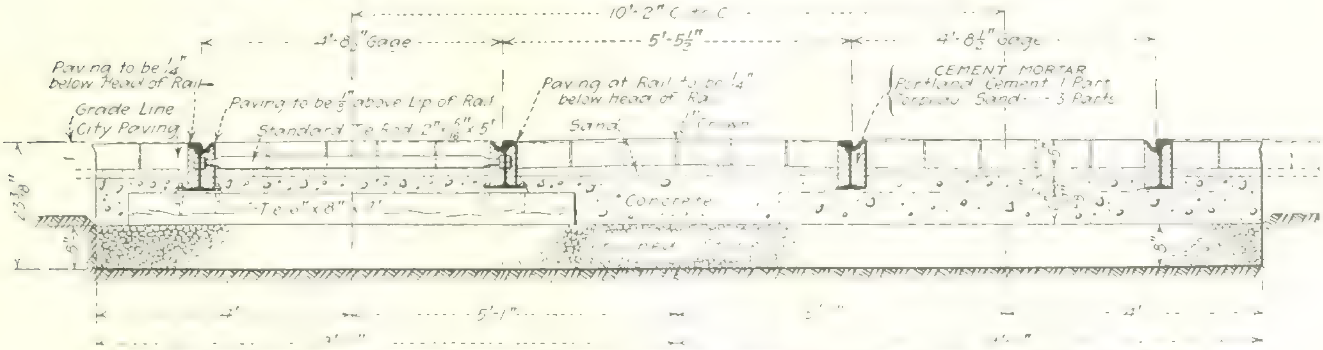


Fig. 3—Type No. 3 of Chicago Standard Track; Crushed Stone With Wood Ties Imbedded in Concrete.

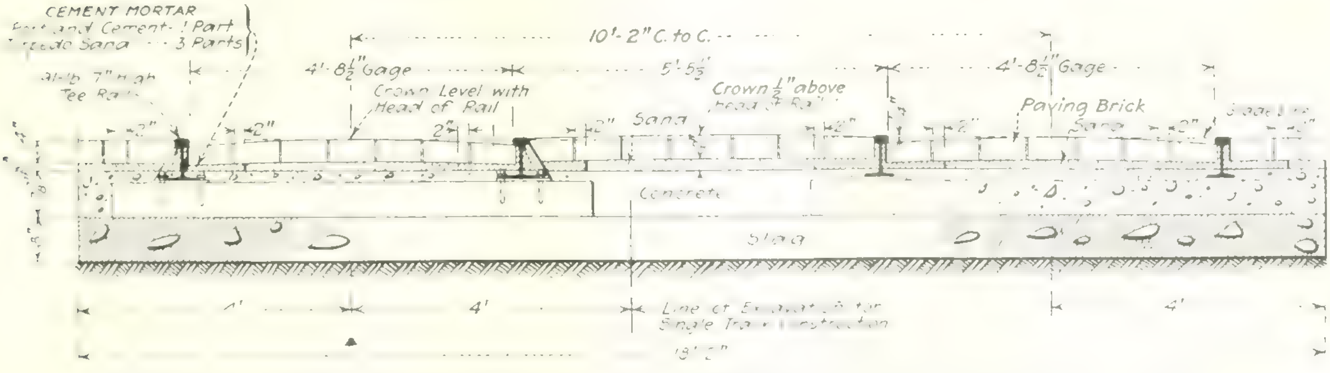


Fig. 4—Type No. 4 of Chicago Standard Track; Slag Foundation With Wood Ties Imbedded in Concrete.

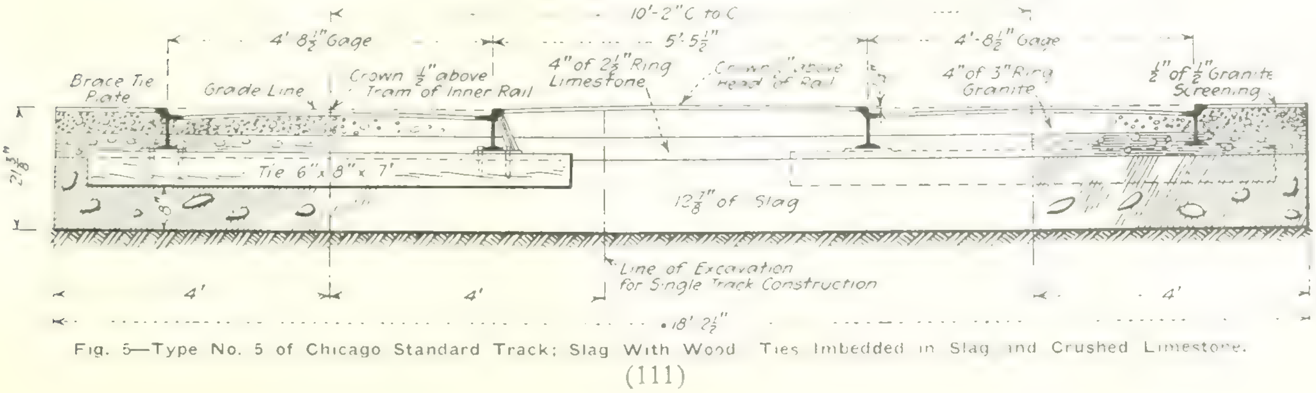


Fig. 5—Type No. 5 of Chicago Standard Track; Slag With Wood Ties Imbedded in Slag and Crushed Limestone.

Damage to Rail by Flat Spots on Freight Car Wheels

[illegible] developed recently be[illegible] American Railway Engi[illegible] Car Builders' Association [illegible] allowable length of [illegible] committee presents its [illegible]

[illegible] average freight car [illegible] Master Car Builders' As[illegible] flat spots at 2½ in. [illegible] increased to 18,750 lb. (the [illegible] lb., and the speed of trains is now much greater, the present Master Car Builders' rules retain the allowable limit at 2½ in.

[illegible] the modern heavy car is many times greater than the impact from the car of 1878, [illegible] due to much higher speeds and the fact that the maximum wheel load is now nearly four times heavier than in 1878. Actual tests have indicated that a 2½-in. flat spot delivers a serious blow to the rail.

Sixteen railroads aggregating 51,000 miles of line reported [illegible] in the present of 2½ in.; this included three roads which reported several hundred rail failures due wholly to 2½ in. flat spots on wheels. Commenting on this subject the committee reports:

It is a fact that rails are broken by flat spots, though specific cases have been difficult to cite, because often the rail, while badly damaged, may not break until some time after the passage of the flat wheel.

The reduction from 2½ in. to 1½ in. would not be very expensive, for the reason that very few additional car miles can be obtained before a 1½ in. flat has become 2½ in., and, further, the greatest damage to the track occurs while the wheel is making these last few miles.

Ordinarily, wheels having 2½ in. flat spots are removed from the axle and scrapped, whereas if the limit were fixed at 1½ in., it would be possible to reclaim such wheels and replace them in service by grinding out flat spots without removing wheels from the axle and at a cost of about $0.60 per pair. Grinding is being done with excellent results on a number of roads and is recognized by authorities as good practice, provided, of course, that the wheel has not been burned during the process of flattening. Therefore, a reduction of the allowable limit from 2½ in. to 1½ in. would not only lessen the impact and damage to the rail, but should prove economical from the standpoint of service in life of wheels.

While it is true that the strength and stiffness of rails has more than doubled (if we assume 60 lb. and 100 lb. A. S. C. E. section as the standards of 1878 and 1917 respectively) and as contended by the Master Car Builders' Association has almost kept pace with increasing wheel loads, it is a fact that this added stiffness of the rail and track structure actually augments the impact from a flat wheel, and this is especially true in winter. Recent tests on the Pennsylvania R. R. show that the average load from a flat wheel recorded on frozen roadbed was from 15 to 25 per cent greater than in warm weather tests.

Increasing the rigidity of the track structure reduces the distance in which a rail may deflect and absorb the energy of a blow from a flat wheel and consequently increases the impact.

There seems to be a misconception as to the meaning of the term "impact." For example:

A given blow from a hammer will not affect a nut placed on a soft rubber mat, but will crack a nut placed on an anvil, yet the striking blow is the same in both cases.

In other words, "impact" is something more than a "suddenly applied load" and must take into account the inertia of the resisting mass, deformation, etc.

The track committee has been informed by the executive committee of the Master Car Builders' Association that it [illegible]

(a) Although maximum car capacity has greatly increased, there has been a corresponding increase in the strength and durability of cars and rails, so that relatively the 2½-in. limit remains quite safe.

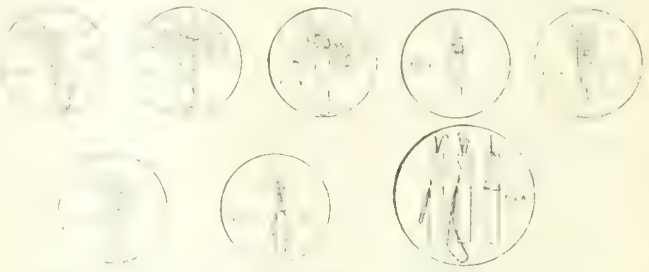
(b) The corners of a 2½ in. flat spot soon become rounded so that the actual impact therefrom is much less than the theoretical; also the force of the blow is greatly diminished by the elasticity of car springs and roadbed.

(c) The reduction of the limit would mean tremendous expense for changing and scrapping flat wheels, and for these reasons the Master Car Builders' Association has steadfastly refused to consider suggestions from the American Railway Engineering Association that the allowable limit be reduced.

Methods of Making Primers with Electric Blasting Caps

Primers should be carefully made: To insure the complete detonation of the explosive; to keep the detonator from pulling out of the explosive; to guard against moisture; to permit easy and safe loading of bore holes. The following methods of making primers, reprinted from a recent circular of the du Pont Co., have proved to be safe and reliable:

Priming in the Side of Cartridges.—For priming a cartridge in the side, a hole is punched about 1 in. or 1½ in. from one end of the cartridge, and pushed in and toward the other end so that when the electric blasting cap is inserted it will be as nearly parallel as possible to the sides of the cartridge. It should never be punched straight through the cartridge, as such a hole would not place the electric blasting cap in the proper position for detonating the explosive. A cap placed in such a hole could be easily displaced or injured in loading. The correct location and angle is shown in Fig. 1. The hole should be deep enough to receive the entire copper shell of the electric blasting cap. The cap is then slipped into the hole and securely fastened by means of a cord tied around both the wires and the cartridge, as indicated in Figs. 2 and 3. This method of priming in the side has the advantage of leaving more space for placing the tamping stick on the primer, but it cannot be used in such small holes as can the end primers on account of the wires lying alongside the cartridge, and thereby increasing the total diameter. It does not place the detonator in quite so good a position as priming in the end.


Three Safe and Reliable Methods of Making Primers.

Priming in the End of Cartridges.—Punch a hole straight into the end of the cartridge to a sufficient depth to receive all of the copper shell of the blasting cap and fasten it there by means of a cord tied first around the cartridge and then around the wires, as shown in Figs. 5, 6 and 7. This is an easily made and highly satisfactory primer. Priming in the end has the advantage of placing the electric blasting cap in the best possible position for detonating the explosive used; but it sometimes has the disadvantage, especially when the bore holes are small, of not leaving sufficient room to place the tamping stick on the primer to slip it into place in the bore hole.

An Excellent Method of Making Primers.—Punch a hole from the center of the end of the cartridge in a slanting direction so that it will come out at the side 2 or 3 in. from the end. Insert the end of the double-over wires of the electric blasting cap and loop these around the cartridge. Punch another hole in the top, a little to one side of the first hole and straight down. The capsule is inserted in this last hole as far as possible and the slack taken up on the wires. The result is a primer where the wires do not cross each other at any point, and the capsule is lying nearly along the center line of the cartridge, and the primer hangs vertically, so that it is possible to load it in the bore hole without its lodging against the sides.

Electrification of Steam Railroads

The following tabulation is taken from the report of the Committee on Electricity of the American Railway Engineers' Association, submitted at the recent convention of the association:

ELECTRIFIED RAILWAYS IN THE UNITED STATES.

Line.	1917, miles electric track.	Trolley voltage	Kind of service, passenger and freight	Power from	K. W. H. 1917, at power house for trains	Records for [illegible] power
Pennsylvania R. R., New York	97	650 DC	Passenger	Coal	[illegible]	None available
Long Island R. R., New York	208	650 DC	Passenger	Coal	97,382,970	None available
Pennsylvania R. R., Philadelphia	35	11,000 AC	Passenger	Coal	23,100,360	None available
W. J. & Seashore	150	650 DC	Passenger	Coal	32,825,600	None available
Grand Trunk Ry.	12	3,300 AC	Pass. and F.	Coal	3,913,300	None available
Northern & Western Ry.	90	11,000 AC	Freight	Coal	[illegible]	Coal cheaper
New York Central	253	650 DC	Passenger	Coal	102,585,000	None available
N. Y., N. H. & H. R. R.	530	11,000 AC	Pass. and F.	Coal	90,500,000	Some water pr.
Michigan Central R. R., Detroit	25	650 DC	Passenger	Coal	7,431,000	None available
Hoosac Tunnel	21	11,000 AC	Pass. and F.	Both	7,727,000	
Baltimore & Ohio, Baltimore	8	650 DC	Pass. and F.	Water	6,200,236	
Chicago, Milwaukee & St. Paul R. R.	600	3,000 DC	Pass. and F.	Water	124,600,000	
B., A. & Pacific	90	2,400 DC	Freight	Water	[illegible]	
Erie (Rochester Division)	38	11,000 AC	Passenger	Water	1,894,860	
Great Northern	10	6,600 AC	Pass. and F.	Water	4,080,000	
Southern Pacific	138	1,200 DC	Passenger	Water	27,844,000	
Total	2,365				675,000,000	

The committee calls attention to the following facts and statements of record:

Direct Saving of Fuel by Electric Operation.—A concrete example of fuel saving by the substitution of electric for steam operation where comparable statistics are available is the electrification of the Chicago, Milwaukee & St. Paul R. R. between Avery, Idaho, and Harlowton, Mont., a distance of 440 miles and comprising an electrification of 600 miles of track. During 1917, 124,000,000 K.W.H. (equivalent to approximately 3,900,000,000 ton miles) were generated by water power for the operation of trains. Based upon actual records taken prior to electrification, 220,000 tons of coal and 453,000 bbls. of oil (equivalent to a total of 350,000 tons of coal) were burned under locomotives for an equivalent steam service. In 1917 there were 2,365 miles of steam railroad under electric operation in the United States and it has been reported to the committee that during the year there were 675,000,000 K.W.H. generated for the operation of trains over these electrified tracks. Applying the figures obtained from steam and electric operation of the Chicago, Milwaukee & St. Paul R. R. to all of the roads electrified, would result in a saving of 1,890,000 tons of coal per annum, had it been possible to produce all of this electrical energy by water power.

A concrete example of fuel saving, where coal is used to generate electric power, is furnished by the Norfolk & Western electrification of about 90 miles of track between Bluefield and Vivian. During the year 1917 there was generated 56,652,000 K.W.H. for the operation of trains, using 87,160 tons of coal at the power house. Based upon records of coal consumption on steam locomotives on the Norfolk & Western, 147,600 tons of coal would be required for an equivalent steam service. Applying a similar saving to the 2,365 miles of electrified steam railroads would show a saving of 720,000 tons of coal per annum if all electric energy had been generated by steam power plants.

Amount of Water Power Available.—The total developed water power of the United States is reported by the Secretary of Agriculture in 1916 as 6,500,000 HP. The undeveloped water power is reported in Senate Document 316, dated 1916, as 53,900,000 HP., of which 39,200,000 HP. is within the limits of the Rocky Mountains and Pacific Coast States.

Calvert Townley in a statement to a committee of the United States Chamber of Commerce, Jan. 14, 1918, made in behalf of the Engineering Council, calls attention to the fact that the Federal Government still retains as proprietor more than two-thirds of the total area of the 13 Western states in which the bulk of the undeveloped water power is located. If any parts of the public lands are needed for reservoirs, dams, transmission lines, etc., a permit of the Secretary of the Interior is required, which is recoverable at any time, without cause. Other water powers are on navigable streams and require an act of Congress for their development. A revision of the laws is under consideration. Outside of the western water power states and the territory tributary to Niagara, water power generally should be developed with auxiliary steam power.

Street Railway Tracks Without Ties

The practice of British engineers in the construction of street railway track is considerably different from that in the United States. As an instance of this the city track construction at Leeds is taken as a typical example, and some details originated by Mr. R. B. Holt, until recently Engineer of Highways and Permanent Way in that city, are described in a recent issue of the Electric Railway Journal.

The track construction consists of concrete laid for the full width of the track for locations where the subsoil is clayey and hard to drain. This concrete is a 1:2:4 mix and is 6 in. thick except at the rail anchorages (15 ft. apart) where it is 12 in. in thickness. Except at these anchorages the rail bases are embedded in a granite chip packing grouted with pitch or some patented compound. Between the concrete sub-base mentioned above and the paving bed there is used a moist mortar layer 2½ in. thick of a 1:4 mix. The ½-in. paving bed for the granite block paving is also of this moist mortar, which when once it has set, tends to prevent water from getting under the loosened rails or paving.

The 7-in. 105-lb. rail used in Leeds in a special design registered by Mr. Holt. Its web is 1/16 in. thicker than the web of the British standard rail of equal weight and is directly beneath the center of the rail tread. The tread is convex and is inclined toward the groove, the convexity and inclination arrived at being the result of hundreds of gagings of partly-worn rail and wheel tire sections. In this form of the tread, Mr. Holt anticipated the design ordered by the Brooklyn Rapid Transit Co. in 1915, although his reason for wanting a coned tread is not the same. It will be recalled that the Brooklyn section was changed in order to reduce such corrugation as seemed due to over-stressing the metal in the rail tread because of insufficient areas of contact between wheel and rail. In Leeds, the change was made to insure longer life and better traction quite regardless of any one factor of destruction. It is not asserted in Leeds that the particular curvature used there should be universal, because differences in rolling stock, brake rigging and brakeshoes, characteristics of rail and wheel metal, etc., must all have some influence in the determination of the most efficient curvature or tread-to-tread contact on a given railway. More than 7,000 English tons of this section have been laid since January, 1910, at Leeds. No extrusion of metal has been observed to date although as many as 2,000,000 cars averaging 11 English tons each empty and 15 loaded have passed over one route so equipped.

The rails are helped to stay to gage by means of 3-in. x 1½-in. tie bars or rods spaced 3 ft. 6 in. The standard rail connection is the thermit weld, some 20,000 welds having been made in Leeds since 1902. In fact, Leeds was the first big undertaking to apply thermit for the elimination of the joint, and it has adopted every improvement which seemed desirable as found by its own experience or the experience of others.

The Leeds system is one of the first users of the Sandberg "Sorbitic" process of hardening the head of a rail in place. The first installation was 2,400 ft. in length. In the two years elapsing since then, more than 250,000 cars have run over the hardened rail, yet Mr. Holt found no evidence of wear. Better still, the incipient corrugations in the rail at the time the hardening process was applied have since disappeared.

MANAGEMENT AND OFFICE SYSTEM

This section is published twice a month: (1) In the Waterworks and Hydraulic Monthly issue, and (2) in the Railway and Excavation Monthly issue. It covers what may be broadly termed "management engineering" as applied in the civil engineering and construction fields.

The Cost Accounting System of Construction Division, U. S. Army

By C. W. PINKERTON

[illegible], Pa.

The basis of the cost accounting system used by the Construction Division of the United States Army during the recent [illegible] of rapid building of cantonments, depots, hospitals, terminals, etc., is the foreman's daily report blank, Fig. 1. The foreman fills out only the left half of the card, which is used for all labor and team service.

When this report reaches the office it goes first to the payroll clerk, who makes his entries therefrom preparatory to making up the payroll. The report then goes to the cost department. After it has been passed by the payroll clerk to the cost department, no change can be made on the payroll without having a corresponding change on the foreman's report involved.

The cost department examines the report to see that all needed information is given thereon. Reports having insufficient details are sent back to the foremen for correction.

From the details furnished by the foremen, the cost clerks make the extensions on the right half of the card and carry the totals to their own books. The form of these books is left to the Cost Engineer on each job to design for himself, and as the writer has seen none which he does not consider too cumbersome none is reproduced herewith. A simple recapitulation sheet in a loose leaf binder will serve the purpose.

Only one job can be reported on one card and each foreman is required to fill out as many cards as the number of jobs on which he works during the day.

At the same time the building inspector turns in daily the form reproduced as Fig. 2, showing the percentage of work done on various items in the buildings under his charge. The card provides places in which he may check progress under columns headed ¼, ½, ¾, 4/4; or instead of checking these he may give the percentage done in figures. Only one kind of building may be reported on one card.

Quantities are determined by the engineers on the job. The quantity of work accomplished or completed during the current week and the total to date may be obtained by two methods: (a) the determination of the total quantities to date and the subtraction therefrom of the quantities reported to date as of the close of the previous week; and (b) the determination of the quantities of work from the point or line of completion as of the close of the previous week and the addition thereto of the quantities previously reported. The first method is generally preferable as it serves as a check against the reporting of excess quantities.

Upon the completion of a project the engineers prepare a report showing the special conditions of labor, weather and all particular difficulties encountered. In reporting labor unit costs, any which are particularly low or high are commented upon.

From the summaries of data obtained the foremen's reports together with the estimates and the progress reports of the building inspectors, the cost engineer prepares on the form shown as Fig. 3 his weekly report of labor unit costs.

The forms (Figs. 2 and 3) are used for all typical cantonment buildings. Two similar forms are used for general construction work in addition to the above and are provided with the classification shown in the center of the right half of the former (Fig. 1). These last cards are used only where large quantities of the work described by the classifications thereon are involved.

An effort was made to adopt a system which would not put a burden on the field forces and which would not require great expense for an organization. It was felt that on each project the field forces should consist of a cost engineer, a quantity estimator, and a cost clerk. The duties of the cost engineer were to:

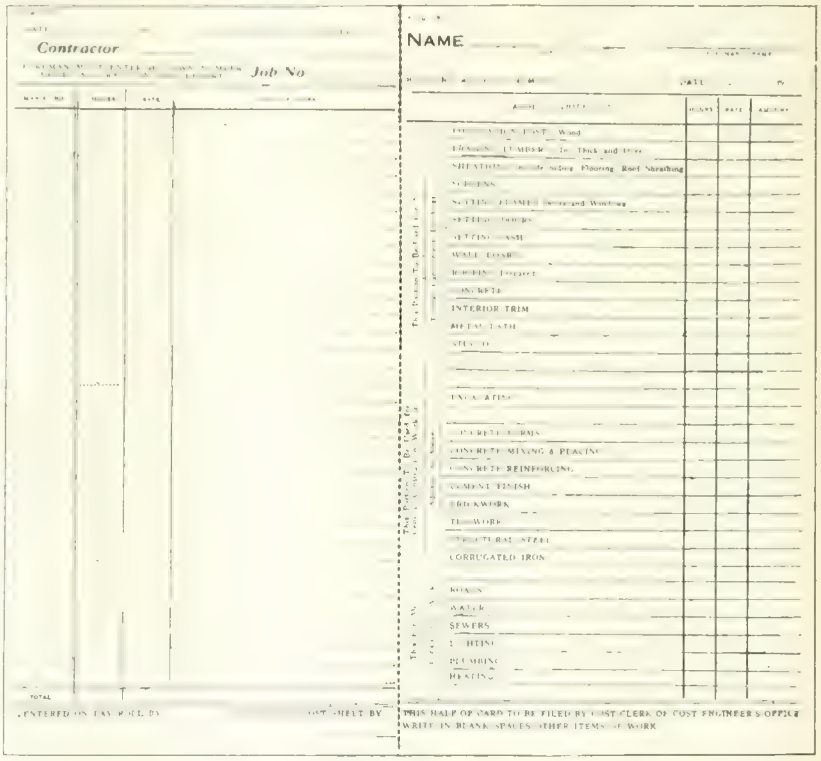
(a) Have general oversight of the field and of the unit labor cost program,

(b) Instruct the foreman in the filling out of form 1901,

(c) Analyze the unit labor costs,

(d) Determine the causes for excessive costs, and

(e) Recommend to the Construction Quartermaster the remedy therefor.



Contractor

Job No

TOTAL

ENTERED ON PAY ROLL BY

COST SHEET BY

NAME

DATE

HOURS | RATE | AMOUNT

SHEATHING Flooring Roof Sheathing

SCREENS

SETTING FRAMES Doors and Windows

SETTING DOORS

SETTING SASH

WALL BOARD

ROOFING Prepared

CONCRETE

INTERIOR TRIM

METAL LATH

STUCCO

EXCAVATING

CONCRETE FORMS

CONCRETE MIXING & PLACING

CONCRETE REINFORCING

CEMENT FINISH

BRICKWORK

TILE WORK

STRUCTURAL STEEL

CORRUGATED IRON

ROADS

WATER

SEWERS

LIGHTING

PLUMBING

HEATING

THIS HALF OF CARD TO BE FILED BY COST CLERK OF COST ENGINEER'S OFFICE

WRITE IN BLANK SPACES OTHER ITEMS OF WORK

Fig. 1—Foreman's Daily Report Blank.
Actual size of form, 8½ in. x 9¼ in.

In addition to this, the cost engineer was given a certain authority over time keepers, material checkers, invoice clerks and purchasing department employes to see that the data needed by him were promptly and accurately furnished. He was allowed to use the time keepers and time checkers for the purpose of returning for correction any reports on which an insufficient or questionable description of work appears.

The classification of buildings worked out by the Cost Accounting Division for comparison of costs of buildings of the same type is being adopted by a number of contractors who have seen it, with, of course, such changes as bring it within the needs of each contractor. This classification consists of a series of primary numbers and another series of secondary numbers.

The primary classification, series 200 and upwards, is used to show the item of construction on which it is desired to keep costs. Each primary account number represents the same item of work or subdivision of the project, wherever used, regardless of appropriation, location, or contract.

The second classification, series 1 to 150 inclusive, is used to show the various kinds of work done under the items of the primary classification. Each secondary account number represents the same kind or character of work regardless of other details.

The primary classification must always be used in connection with the secondary classification. For example, if the building being constructed carries the primary classification account No. 201 and it is desired to charge plumbing (secondary classification No. 18) against that building, the cost distribution would be 201-18.

The classification follows:

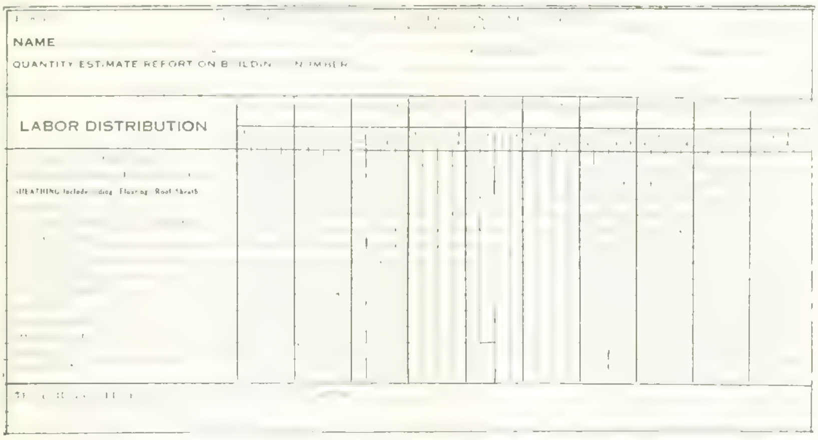
Primary Acct. No.	Type or Class of Construction
201	60 men barracks, 30 ft. x 60 ft.
202	Two-story buildings, 20 ft. wide.
203	Two-story buildings, 30 ft. wide.
204	Two-story buildings, 43 ft. wide.
206	Types G. & H. officers' quarters.
207	Lavatories.
208	Latrines.
209	Showers.
210	Post office.
211	Detention huts.
212	Assembly halls.
213	Storehouses, 60 ft. wide.
214	Two-story warehouse, 72 ft. x 116 ft.
215	Magazines.
216	Shops, 36 ft. wide.
217	Blacksmiths shops.
218	Closed stables, 24 ft. wide.
219	Open stables, 24 ft. wide.
220	Open sheds, 29 ft. wide.
221	Hay sheds.
222	Watering troughs.
223	Feed troughs.
224	Hay racks.
225	Loading platforms.
226	Dipping tanks.
227	Fences and gates.
228	Flooring and framing for tents.
231	65 ft. wide garages.
232	Fire stations.
233	Grain storage elevator.
234	Motor and service station and repair shops.
235	Repair shops, 60 ft. wide.
236	Lecture halls, 120 ft. x 167 ft.
237	Drill halls, 200 ft. x 300 ft.
239	Coffee roasting plant.
246	Delousing plant.
401	Ice and cold storage plants.
402	Laundry buildings.
403	Bakery buildings.
404	Incinerators.
405	Reservation fences.
502	Library theater.
701	Hospital building (one story frame).
703	All two-story masonry and frame.
704	All other buildings.
705	Connecting corridors.
846	Well houses.
1025	Power house.
1706	Coal trestle.

Secondary Classification to cover details of construction used in connection with the Primary Classification.

Secondary Acct. No.	Details
3	Excavation and backfill.
7a	Foundations, masonry, and
7b	Foundations, steel (these accounts to be used only if building is very large or will house heavy machinery and equipment).
9	Concrete (can be used for concrete piers, floors, etc., or when large quantities of concrete are poured. State why account is used, i. e.: Concrete piers, and floors, concrete walls, etc.).
15	Carpentry.
	a—Foundation posts (wood).
	b—Framing and erecting lumber (2 in. thick and over).
	c—Sheathing (including siding, flooring, roof sheath).
	d—Setting frames for doors and windows.
	e—Setting doors.
	f—Setting sash.
	g—Interior trim.
[illegible]	Screens.
57	Wallboard.
42	Roofing (state kind).
17	Painting.
18	Plumbing.
19	Ranges and kitchen equipment.
20	Heating, stoves.
23	Sheet metal work.
25	Elastic lighting, interior.
33	Tile (used for walls, partitions, etc.)
31	Structural steel (used only in large structural steel construction).
38	Permanent machinery or equipment.
	a—Pumps and piping.
	b—Engines.
	d—Boiler house equipment.
	f—Switchboard.
	k—Miscellaneous equipment or machinery.
[illegible]	Fire protection.
	a—Fire apparatus.
	b—Sprinkler system.
	c—Fire alarm system.
41	Miscellaneous iron work (does not include reinforcing for concrete).
65b	Doors, steel or fire doors.
69	Foundations for machinery (cost to be collected under this account only when extra foundations are placed to accommodate machinery and should not be confused with 7a and 7b).
89a	Tanks, steel (to be used for gasoline pump stations).

The weekly total cost report is prepared on the form illustrated as Fig. 4. In this form, under column for accounts is typewritten the list of needed account numbers in accordance with the classification. Opposite the number the description of the work and the number of buildings with dimensions should be placed, as

"702 Two Story Frame Hospitals (6) "x " " "



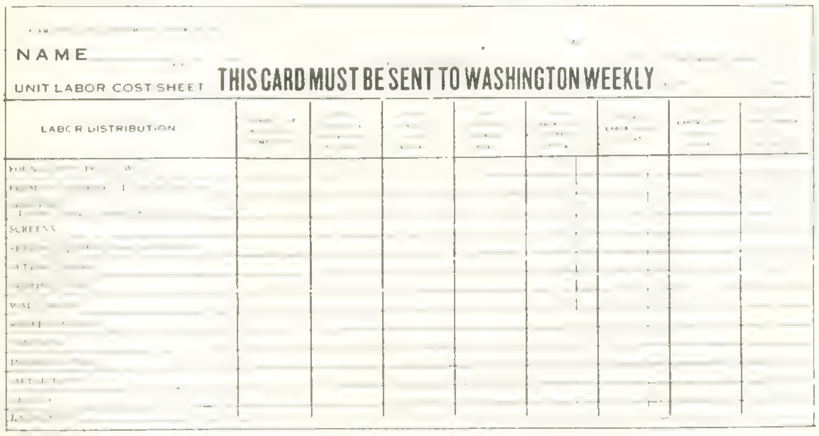
NAME

QUANTITY ESTIMATE REPORT ON BUILDING NUMBER

LABOR DISTRIBUTION

SHEATHING Including Flooring Roof Sheath

Fig. 2—Form Used by Inspector for Reporting on Work Done on Various Items in Building Under His Charge.
Actual size of form: 11½ in. x 8½ in.



NAME

UNIT LABOR COST SHEET **THIS CARD MUST BE SENT TO WASHINGTON WEEKLY**

LABOR DISTRIBUTION

SCREENS

Fig. 3—Form for Weekly Report of Cost Engineer on Labor Unit Costs.
Actual size of form: 11½ in. x 8½ in.

Below this line the proper sub-heading or secondary numbers, as

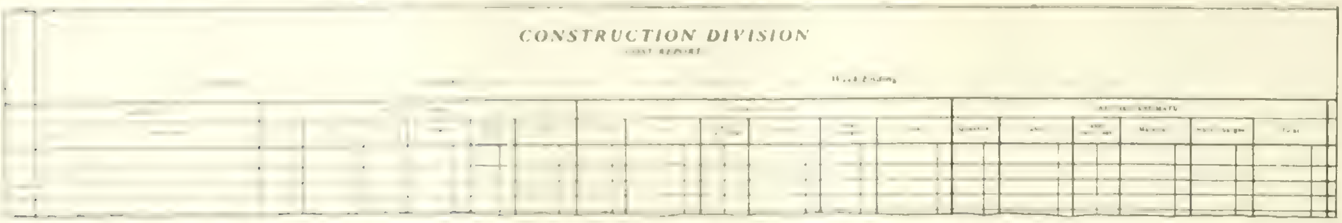
3 Excavation.
15b Framing.
15c Sheathing.
15e Setting doors.
57 Wallboard.
18 Plumbing, etc.

Transfer the distribution of payrolls under labor column, and materials and supplies under material and supplies column on the cost forms. The five totals as shown at end of cost accounting classification schedule as furnished by the cost department are self-explanatory.

A. Total direct cost is totals of form (Fig. 4).
B. Total indirect cost is totals of form (Fig. 5) transferred.
C. Total cost is totals of direct and indirect cost.
D. Unpaid wages. This shall be deducted from labor and total columns.
E. And the balance should equal the total [illegible] [illegible] with total [illegible] ing date.

The material entries are for totals paid during the week, not for the value of the materials used in connection with the labor entries.

The revised estimate when properly kept up on the basis of costs to date is one of the most valuable features of the system. Immediately upon receiving an authorization for [illegible] [illegible] the Constructing Quartermaster has an estimate of [illegible] [illegible] [illegible] [illegible] in the detail required for each [illegible], showing quantities and unit estimated costs. Further, as the work progresses, and the cost on the work has once been ascertained, a revised estimate [illegible] [illegible] to [illegible] the estimate. In this way, knowing the percentage of completion, the constructing quartermaster has complete a detailed statement of his estimates [illegible] all items are required to be given weekly on small quantities such as concrete for foundations of frame structures, nor on overhead, prorate and indirect charges. Labor unit costs are required on those items of direct classification which are listed on the form (Fig. 4), and which items have quantities sufficiently large to justify the work involved. No labor unit costs are shown on such items as plumbing, lighting or heating while the job is in progress.


CONSTRUCTION DIVISION

COST REPORT

Week Ending

Fig. 4—Form for Weekly Total Cost Report. Actual size of form, 15 in x 21¾ in.

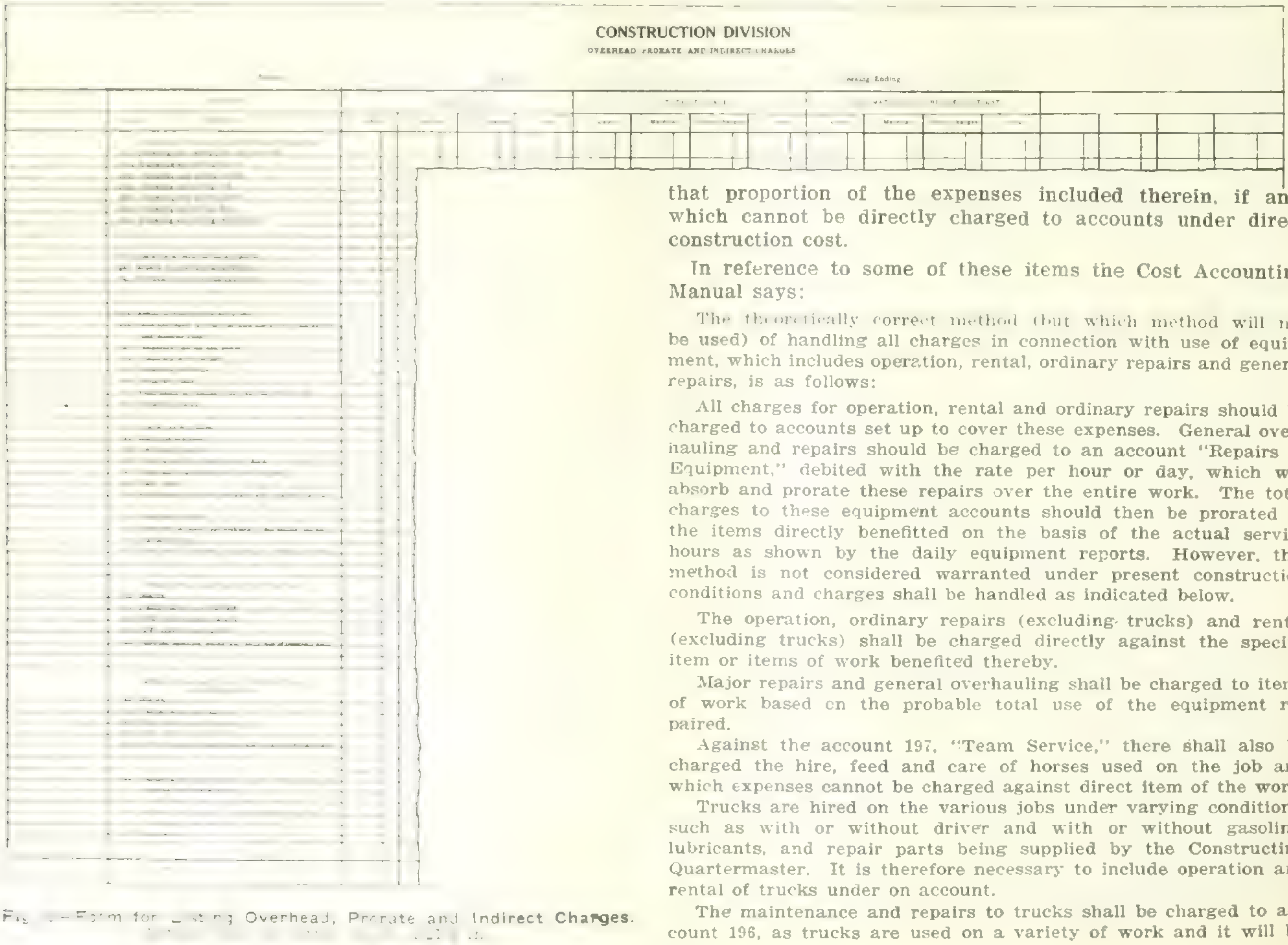
Chief among the unusual features of the system is the great number of items included under overhead, prorate and indirect charges, among which may be mentioned the unloading, loading and hauling of practically all materials and the cost of all temporary buildings, structures and roads, even when such temporary construction could be directly charged to one item of the work.

For example: A car load of material is received, unloaded and piled temporarily at the unloading plant; later it is hauled to a central storage yard; a part of it is then transferred to another storage yard or sub-depot from which point it is hauled to the proposed site of the job on which it is to be used. All expenses herein incurred, including the delivery at the site of the job, are charged to the overhead account and not to the job on which the material is to be used. Any expense incurred in connection with the distribution of plant and materials after delivery has been made to the site of the job on which they are to be used is charged directly to the operation for which the materials are intended. An example of this is the carrying of wallboard into a building from the place where it was unloaded from wagon or truck at the door, which is charged to placing wallboard in that building. The costs of buildings, therefore, do not, until the overhead has been added to the other costs, include the item which contractors ordinarily call teaming.

On the other hand all expense of unloading and hauling materials required for the construction of pipe lines, pole lines, railroads, roads and like facilities is not charged as above, but is charged directly to the construction of the facility for which the material is handled.

Unless one realizes the large number of items included under overhead by the government, the high percentage of the overhead charge in government cost reports is likely to be surprising. This teaming item alone involves large expenditures. At Camp Beauregard, La., the overhead was so high as to cause 48 per cent to be added to the cost of each piece of work done. This was not because of extravagance or carelessness, but simply because of the breadth of the classification.

A complete list of the items included under overhead, prorate and indirect charges appears on the form Fig. 5. Accounts 152, 153, 155, 196 and 197 on this form consist only of that proportion of the expenses included therein, if any, which cannot be directly charged to accounts under direct construction cost.


CONSTRUCTION DIVISION

OVERHEAD PRORATE AND INDIRECT CHARGES

Week Ending

Fig. 5—Form for Listing Overhead, Prorate and Indirect Charges.

In reference to some of these items the Cost Accounting Manual says:

> The theoretically correct method (but which method will not be used) of handling all charges in connection with use of equipment, which includes operation, rental, ordinary repairs and general repairs, is as follows:
>
> All charges for operation, rental and ordinary repairs should be charged to accounts set up to cover these expenses. General overhauling and repairs should be charged to an account "Repairs to Equipment," debited with the rate per hour or day, which will absorb and prorate these repairs over the entire work. The total charges to these equipment accounts should then be prorated to the items directly benefitted on the basis of the actual service hours as shown by the daily equipment reports. However, this method is not considered warranted under present construction conditions and charges shall be handled as indicated below.
>
> The operation, ordinary repairs (excluding trucks) and rental (excluding trucks) shall be charged directly against the specific item or items of work benefited thereby.
>
> Major repairs and general overhauling shall be charged to items of work based on the probable total use of the equipment repaired.
>
> Against the account 197, "Team Service," there shall also be charged the hire, feed and care of horses used on the job and which expenses cannot be charged against direct item of the work.
>
> Trucks are hired on the various jobs under varying conditions, such as with or without driver and with or without gasoline, lubricants, and repair parts being supplied by the Constructing Quartermaster. It is therefore necessary to include operation and rental of trucks under on account.
>
> The maintenance and repairs to trucks shall be charged to account 196, as trucks are used on a variety of work and it will be

difficult to charge these expenses against the specific items of work on a correct basis.

166—Cleaning Up After Completion of Work: To this account there shall be charged all expenses incurred in connection with the cleaning up and disposing of refuse, waste mterial, etc., after the construction work is completed.

Any expense of this nature incurred during the progress of the work shall be charged directly to the secondary account number responsible for the accumulation of such waste . . . . .

No charge shall be made to this account for work done in any building until all the construction work in that building is finished.

To this account there shall also be charged all expenses incurred in connection with the disposal of waste material and the ing construction.

Many of the cost engineers and contractors working for the government objected to this classification, the cost engineers because it did not follow the usual practice and the contractors because it makes the overhead percentage seem so high. The further objection was raised that since the total overhead is eventually to be divided among all jobs worked on at the place where the overhead was incurred, certain items will bear a very unfair percentage.

But the Cost Keeping Department felt that because of the many varying conditions met at the various projects it was impracticable to establish any exact basis of comparison of these expenses, and that it was essential that these expenses be kept as directed. A letter from the Chief of the Construction Division to all Constructing Quartermasters said:

> Uniform results are the only results which will be of benefit to the Construction Division as a whole, and all units and all methods of obtaining costs should be the same; therefore, even though the costs submitted from a camp or project are excellent in themselves, if they do not conform to other projects they will not render the service expected. For this reason the cards sent you, the units suggested, and the methods outlined should be followed throughout, in order that all results may be uniform.

Equipment rental is carried on the payroll. The equipment is checked every day and a proper record made of the work the different pieces of equipment are engaged on. The rentals are charged against the accounts in the same manner as other payroll items but idle or non-productive time of the equipment is charged to account number 155, idle equipment account.

It will be noticed that practically all of the details of this system relate only to labor costs. It was felt that, while one superintendent as compared with another or one project as compared with another project might make more or less saving in material, yet the difficulties of carrying the materials through stock accounts under existing conditions were too great to justify the work. The efficiency of construction work from the administrative viewpoint is determined by the labor unit costs.

While the material is not carried into the unit costs during the progress of the work yet strict account of it is supposed to be kept.

The material purchase order as placed is the basis for the distribution of material costs except where the material is not used as specified on the original purchase order. Exceptions to this rule may be the result of the following:

1. The placing of purchase orders for material in excess or the amount required in the construction of the project.

2. A change in plans, reducing the size of the project as a whole or the elimination of or reduction in size of certain parts.

Transfers of material are handled in the usual debit and credit manner.

Under ordinary conditions it is believed that carrying the material through the usual stock accounts is much more satisfactory than the method above outlined.

On most construction projects more than the regular number of working hours per day were being worked. For the additional time worked or overtime the rate of pay was generally more than straight time. This means that a certain number of hours and a certain amount of money were being paid in addition to the actual number of hours worked. Bonus Hours were defined by the Cost Accounting Manual as "the number of hours paid for in excess of the actual number of hours worked, or as that number of extra hours given to workmen as additional compensation for work performed on other than regular working days or during hours other than those which constitute the regular working day."

Two examples are given below:

If the standard working day consists of 8 hours and time and a half is allowed for overtime and 10 hours are actually worked, the workman would receive pay for 11 hours or a bonus of one hour. If a workman works 8 hours on Sunday and time and a half is allowed for all Sunday work, the workman will receive pay for 12 hours or a bonus of four hours.

In all projects a record of bonus hours and bonus money is kept under each employment, that is, trade or class of labor and rate of pay, showing the following data for both the current week and the total to date:

Rate per hour.
Total hours paid.
Total amount paid.
Total hours paid without bonus.
Total amount paid without bonus.
Total hours paid bonus.
Total amount paid bonus.
Percentage of pay roll.
Percentage of pay roll less bonus.

The items "Percentage of Payroll" and "Percentage of Payroll less Bonus" refer to the bonus, which shall be computed on the basis of hours as the money bears the same relation as the hours, and the hours will be smaller figures to use in computation.

The changed attitude toward the value of cost keeping is shown in the following paragraphs introductory to the cost manual:

> The importance of the keeping of cost analyses and unit costs has never been as generally recognized as at the present time. Never in the history of this Government has construction work been carried on under such conditions as exist today: Never has such a vast building program been undertaken as is now going on under the present extraordinary economic conditions.
>
> The prodigious increase in the cost of building materials and the existing unprecedented labor conditions emphasize the importance of cost analysis and the value of unit costs . . . . .
>
> Cost reports are essential for the following purposes:
>
> (a) To intelligently forecast the ultimate cost of the project during the process of the work.
>
> (b) To aid in the making of estimates on future work.
>
> (c) To make possible such comparisons as may be desired on units, buildings or projects of like nature.
>
> (d) To show unit labor costs during the progress of work and for the completed project; also to show total unit costs for all expenditures which include material and other charges in addition to labor, when project is completed.
>
> (e) To enable this Division to compile such reports with reference to costs as may be desired or required by the Secretary of War, any Appropriation Committee or for the permanent records of the Construction Division.

Cost of Driving a Mining Tunnel at Park City, Utah

To eliminate shaft-sinking, hoisting, water difficulties, and the surface transformation of ore and supplies, also to develop its property, the Silver King Consolidated Co. is driving the Spiro tunnel at Park City, Utah. The size of the tunnel is 8 by 8 ft., with a ditch 3 by 4 ft. The advance during 1918 was 4,001 ft., making a total of 9,001 ft. The present depth from the surface is 1,300 ft. The daily rate was 10.9 ft. The greater part of the distance has been in "Woodside" shale, but in October last year this formation gave place to limestone, alternated by bands of shale. In the 4,001 ft. driven during 1918, timbering was required in 1,960 ft., also temporary stulling after each blast before the broken rock could be removed. At one point, for 300 ft., the ground required 10-in. timbers set at 4-ft. centers, instead of 8-in. timbers at 5-ft. centers. The lower stratum of the red shale was tough and springy. It drilled easily, but required 22 to 24 holes, heavily loaded, to break to the bottom of the holes. The cost of the work, according to the Mining and Scientific Press, was as follows:

	1918. 4,001 ft.	1917. 5,000 ft.	Total length, 9,001 ft.
Labor cost, per ft.	$18.63	$13.52	$15.74
Material cost, per ft.	11.86	8.10	9.77
Total	$30.49	$21.62	$25.51

$500,000 Wanted for Topographic Mapping.—The Engineering Council has asked the Secretary of the Interior to recommend to the 66th Congress the importance of increasing the appropriation for the topographic mapping of the country from $350,000 to $500,000.

Accounting as Applied to the General Contractor*

By [illegible] WEATHERWAX

[illegible]

A [illegible] of the contractors present no two [illegible] one man has a very [illegible] that [illegible] can understand ex[illegible] the next man has [illegible] of an envelope in his inside pocket, the third man doesn't keep books at all. This wide divergence in the matter of accounting, together with a similar lack [illegible] in the matter of estimating and cost keeping [illegible] for the wide divergence noted at almost every opening of bids. It is partially responsible for the feeling of distrust engendered in the minds [illegible] the very people without whom [illegible] of small— when we go to them for a legitimate business loan or require a bond.

[illegible] method or rather lack of method in accounting, estimating and cost-keeping is again responsible for the feeling in the mind of the general public that the extremely low bid is the correct bid and all the other bidders are robbers. We must also combat the idea in the public mind that was originally conceived in the mind of the cartoonist, that of the contractor with his pockets stuffed [illegible] a wide expanse of vest, big, fat, jolly, rolling in opulence. We are distrusted by everybody. Our banker thinks we are gambling. Our bondsman thinks we are padding our assets, and the architect and owner think we are combined to take excessive profits from our work, when as a general rule when we go to our banker for a loan, it is [illegible] a legitimate requirement of our business.

For our own good as well as a means of raising us in the [illegible] of our fellow citizens let us devise some general scheme of accounting which will at once be capable of expansion to care for the needs of the largest operator as well as for the man whose limited capital necessitates the accepting of smaller contracts. With two or three exceptions we are all operating on a capital invested of not to exceed $100,000 and it should not be a serious matter to devise some standard guide by which we could all work, varying details to suit our individual requirements and the time is not far distant when either we shall have to take steps towards some such standard form of accounting or our Government will do it for us.

Do you know that the lumbermen spent some hundreds of thousands of dollars in an effort to standardize their accounting and cost records so that they could "account" to the Government for every item entering into the manufacture of lumber of all grades and thus convince the Government that they were not profiteering. You have noted that lumber prices have been pretty much the same as between different mills. It is not because they have gotten together and said that such and such a price shall be charged, but primarily because they have a standard system of cost-keeping and accounting which shows them that it is costing them approximately the same to manufacture and market their product—allowing of course for rail facilities, stock on hand, etc. They have found that some such system was absolutely necessary in order that they might put themselves right with the public; and some such system is just as urgently needed by the contractor for his business.

Then again we are harassed periodically by the state in the collection and reporting of contributions to the industrial insurance and medical aid funds, while in states having no such laws we are forced to carry liability insurance, our payrolls subject at stated intervals to audit by state or private officials. A five minutes' talk with one of the auditors for the state industrial insurance commission would convince you that the contractor generally speaking has very little idea of accounting. The very provisions of the laws as regards the percentage of contribution are supposedly based upon the percentage of accident in the different trades employed in the construction of a building, consequently we are required to make at least some segregation of our payrolls, at least as between laborers, carpenters, roofers, painters, etc., each of whom have different accident ratios, consequently different premium rates per dollar.

Some of us have a daily report system, very complete and also very costly, kept by the foreman who in the rush on the job generally forgets all about the report until night, then puts down something to satisfy the office—sometimes correct, but ofttimes not. On large operations justifying the employment of time clerk and cost clerk combined the tendency is to go into too much detail and swamp the "accounting" office with a mass of detail and costs which are carefully worked up and then forgotten.

Periodically we are asked by Dun or Bradstreet to furnish them with a statement of our assets and liabilities, generally accompanying the request with one of their printed forms which those of you who have had that experience will know is adapted to the ordinary manufacturer, merchant—any business but that of the general contractor. We wrestle with their form and finally give them something to satisfy them, either on their form or one we have pounded out in haste for ourselves. The result is generally not very illuminating either to them or to us and leads us into a false sense of financial values.

The same is true of many banks. When a customer goes to his banker for a loan, unless he has adequate collateral, the first thing requested of him is a prerequisite to any consideration of his application for accommodation is a financial statement showing in tabulated form his net worth. All of us use or should use our bank as our financial adviser and counsellor, and in the line of credit allowed us by our bank we find an answer to what our bank thinks of us as financial risks. We all know that banks generally are not overly anxious for the contractor's business for several reasons. The average contractor by the very nature of his business cannot keep large average balances. He makes relatively few deposits and writes hundreds of checks, making work for the bank's bookkeepers. On top of this the very nature of his business again tends toward unconscious inflation of his net worth, especially where several operations dovetail one into the other. We must make our banker our confidant, must instill a feeling of confidence in him, and one of the first ways of establishing such relations is by means of a monthly balance sheet, using care to see that for comparative purposes it is always on the same form. For the betterment of the profession as a whole, why is it not logical to devise a standard form of balance sheet for the use of all contractors? Such a form could easily be prepared when the monthly trial balance is taken, and, should the contractors as a class voluntarily on the first of each month mail to their bank and to their bondsman a copy of their balance sheet, it would go a long way towards procuring for us as a whole the good will and confidence of the very people we must conciliate, to say nothing of the great good to our credit among supply houses who universally use the services of Dun and Bradstreet in an effort to keep a line on the financial responsibility of the general contractor.

Let us as members of an association comprising the Northwestern states, devise a standard payroll sheet, preferably loose leaf, which will provide for medical aid and insurance tabulations as well as private cost records, band reconcilements, etc. Let us devise a check register for handling our general account, which will enable us to segregate our payments to the different operations without the necessity of first running all accounts through a bulky journal. Let us devise a uniform balance sheet to be used for the information of those entitled to have such information. Then let us all use them, go to our bank and our bondsman and say: Hereafter you will receive a copy of our balance sheet each month on this form that you may know as well as we just what our business is doing.

I cannot hammer home too strongly the fact that as a class we are considered shaky financially. If we are to make these people know that we are substantial we must take steps to convince them that we are going to do business along proper lines, and what better way than to be able to say that we, too, have had our "house cleaning," that we too, by our very determination, are going to demand that we be considered as business men, and then back up our assertion with vital information in the proper place. In this way will we pave the way for better business, better credit and better associations with those upon whom we are dependent.

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*[illegible] Northwest Master [illegible]

Cost Accounting as Applied to Sand and Stone Production*

By TOM P. M'GRATH,

Of McGrath Sand and Gravel Co., Lincoln, Ill.

My purpose will be to show that the accounting department of the present-day sand and gravel business can be made as valuable an essential to the business as the producing or selling departments.

Just what part the accountant plays in making the sand and gravel business, or any business in fact, profitable, I am going to explain as I see it, after 14 years' experience in accounting.

In the first place, to speak correctly, there is no such person as an expert accountant. We often hear men called expert accountants, but at the most, they are only specialized accountants, for accounting is too broad a field for a person to become an expert in all its branches. Cost accounting, for any particular business, can only be intelligently applied after an exhaustive study of all conditions that govern that particular business.

I will enumerate just a few of the things that every accountant in the sand and gravel business should look out for.

Liability Insurance. Present statement to your insurance agent of losses sustained during the years of operation, and if losses are low and the rate is high, keep on the subject until an experience rating is given.

Fire Insurance.—The same thing applies here. If all the operators have this matter up, we will have more success in getting a reduction in rates.

New Accounts.—Immediately upon the opening of a new account, get a rating and preserve it.

Collections.—Use a good follow-up system. Be able to write a good letter, and not one of the rubber stamp kind. A good letter is short and direct, diplomatic and at the same time, convincing.

Bookkeeping.—Trial balance system, statements of assets and liabilities, and trading profit and loss, as often as necessary to keep in touch with the condition of the company, at least once a month.

Operation.—Watch the daily tonnage report. If not up to standard, notify the manager of operations, and then it is up to him to correct the fault.

Banking.—Watch your bank account and never overdraw it. It is a bad habit and destroys credit.

Stripping.—The cost of stripping, or overburden, should be placed in Miscellaneous Assets, and monthly charges made against this account in accordance with the amount of stripped surface consumed.

Bad Accounts.—When every means to collect an account has failed, charge it off. Then if later on the account is collected, apply it to earnings of the current year.

Taxes.—The accountant should familiarize himself with the normal income, excess and war profit tax exemptions, allowances and deductions as they affect his own line of business.

Depreciation.—The rate of depreciation should be arrived at in the same way as an experience insurance rate is figured, namely, if the average life of your plants in the past has been 10 years, the depreciation should be charged at 10 per cent of the original cost. A replacement reserve account should be opened and credited with the amount charged to depreciation. If the replacement reserve becomes equal to the original cost of the plant, no further charge.

Obsolescence.—In case the plant becomes obsolete before the replacement reserve has become equal to the original cost of the plant, the difference between the replacement reserve and the original cost, minus the salvage value, should be charged to obsolescence.

If you are operating a plant whose normal life is 10 years, on property on which you have a lease for only five years, without privilege of extension, then a yearly charge of 10 per cent for depreciation and an additional 10 per cent for obsolescence, making a 20 per cent charge against the original cost, should be made.

Repairs and Supplies.—When repairs and supplies are brought to maintain the plant in operation, they should be charged against expense, and not entered under assets which would show an increased valuation of your plant.

Depletion. The depletion charge allowed by the Government in computing taxes is based upon the cost of the gravel property, plus the cost of that part of the property that the plant, equipment and switch tracks occupy, from under which the sand and gravel cannot be excavated.

ORDINARY ITEMS OF EXPENSE OF A SAND AND GRAVEL COMPANY

- Administrative
    - Bad accounts.
    - Taxes.
    - Depreciation of office furniture and fixtures.
    - General expense.
    - Interest and exchange.
    - Maintenance expense.
    - Office rent.
    - Office supplies.
    - Postage.
    - Manager's salary.
    - Office salaries.
    - Insurance.
    - Telephone and telegraph.
- Selling
    - Salesmen's salaries.
    - Traveling expenses.
    - Auto.
    - Commission.
- Operating
    - Labor.
    - Repairs and supplies.
    - Coal.
    - Freight.
    - Power.
    - Drayage.
    - Switching.
    - Liability, fire, tornado and boiler insurance.
    - Royalty or depletion.
    - Demurrage.
    - Stripping.
    - General expense.
    - Depreciation of plants and equipment.
    - Obsolescence.

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[*] Abstract of a paper presented for a meeting of the Accountants of the Illinois Sand and Gravel Producers' Association.

Schedules That Aid in Getting Out Work on Time

To keep work up to date some kind of a schedule is almost always necessary. The kind of schedule used may vary with the type of work to be followed. But the principles for making effective schedules—schedules that serve as accurate reminders and succeed in getting the work done on time—are fairly simple, states Arthur Van Vlissingen, Jr., in System.

Analysis of a large number of schedules used to keep track of various kinds of work seems to indicate that there are about five basic methods of scheduling; to each kind of work one of these methods, or some variation of it, is usually found to be best adapted:

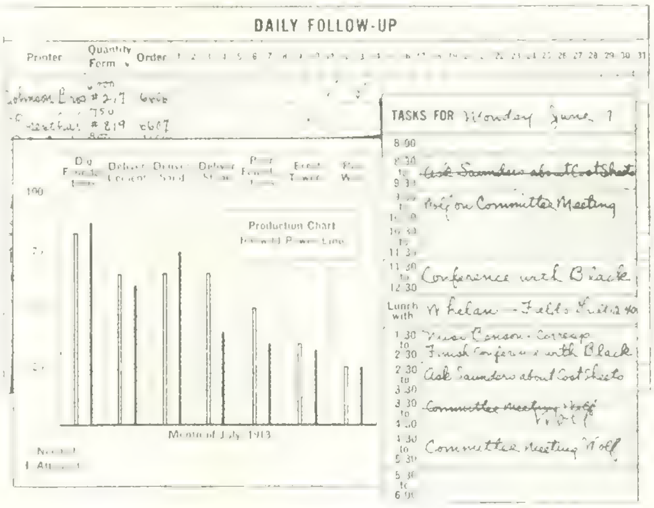


Fig. 1—Charts Used by Executives in Three Lines of Work.

The upper sheet supplies a purchasing agent with a follow-up on deliveries, the left-hand graph locates delays for a contractor and the right-hand list helps a manager keep his appointments.

1. The tickler—daily, weekly, or monthly.
2. The follow-up sheet.
3. The plan board or sheet.
4. The list of tasks, when time set.
5. The progress chart.

There are many varieties of ticklers, each suited to its own class of work, from the card index, with a card for every day and month, and which an executive may keep in a desk drawer, to the "memory file" that is similarly arranged and may serve to remind all the members of an office force of the duties ahead of them.

[illegible] to the follow up sheet [illegible] successful is in [illegible] which buys a good deal of printing. When he first devised the method this pur- [illegible] He is gradually ex- [illegible] however.

[illegible] in Fig. 1. As he [illegible] followed up, he writes in the name of the printer, the quantity and form num- [illegible] a check in this horizontal column, beneath the date on which delivery is [illegible]

[illegible] telephones each printer [illegible] gets promises from the printers, and reports them to the purchasing agent. If [illegible] date, he makes another check under that date. If he needs delivery sooner he [illegible] the arrangements.

When a job is delivered he checks the date in red and crosses out the whole horizontal column. Every day the stenographer recopies the sheet, thus bringing it up to date.

[illegible] clipping them on a board. When he needs any reasons to show a printer why he should speed up delivery, he can usually get a forcible argument by consulting the sheaf.

For work which involves repetition of the same operations time after time, and which comes in regular cycles of weeks, months, quarters, and longer periods, a plan board or plan [illegible] means of scheduling.

In a New York concern a number of plans enable one of the executives to get his work out on time. In the first place, he divides his work into routine and creative. Experience has shown him that he usually thinks to best advantage in the afternoon. So his mornings are devoted to routine—dictation, conferences with his assistant, and some of the officers of the company whose work is along the lines of his routine. Afternoons are given over to creative work, in which he includes meeting callers, and conferences with the president of the company on questions of future policy.

But merely saying "mornings for routine" and "afternoons for creative work" did not entirely solve his problem, he found. And so he went into the situation in detail with his secretary; he explained just what he wanted to handle in each classification. Now she guards him from any unwelcome intrusion during the hours which he has set aside for creative work.

Each morning he finds under his glass desk pad a list of tasks for the morning and tasks for the afternoon, made out by his secretary. He checks these over as soon as he gets to the office and then tries to follow the plan all day.

This man, with the other high executives of his concern, uses a "silence room" on occasion. Placed in a remote corner of the office, it is regarded by the whole organization as "out of town." When this man wants to do some creative work or creative thinking undisturbed, he goes to the silence room. He may find one or two other executives there. But no greetings are exchanged. The silence of the room must be respected by every one all the time.

A caller who asks for this executive while he is in the silence room is told that Mr. Jasper cannot be disturbed. Only in an emergency does his secretary attempt to reach him in the silence room.

Thus by dividing his day, listing his tasks, and retreating on occasion to the silence room, this executive carries a load —up to date all the time—that might well swamp a man who worked less methodically.

Still another plan for getting work finished on time is used by a Chicago business men. Every morning he transfers all notes about appointments from his calendar pad to this sheet. During the day, as "things to do" occur to him and crop up in his work, he jots them down for the hours best suited to his convenience. As a task is completed or postponed he crosses it off or notes it farther down the sheet.

He keeps this sheet under his glass desk pad, just beside his left hand. He makes a point of glancing at the sheet whenever he notices the time on his desk clock. In consequence he has gained among his associates an enviable reputation for punctuality.

An unusually effective production chart is used by the general manager of an engineering firm to make sure that all work will be completed within the stipulated period. A sample chart for one month is shown in Fig. 1.

At the beginning of the month a blue print showing the work that has to be done goes to the general manager, to the superintendent of the job, and to each of the assistant superintendents who have charge of the individual operations.

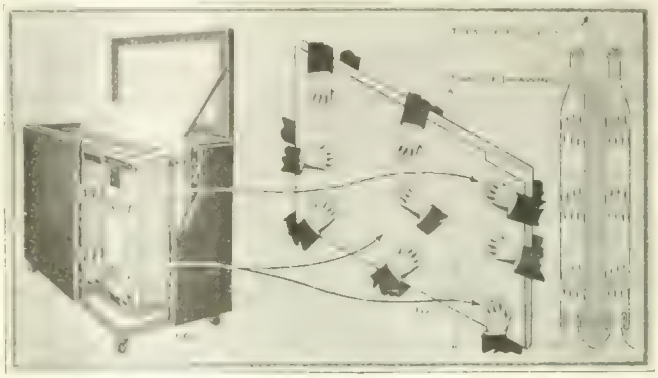
The percentage of each operation which is to be completed by the end of the month is shown by a double line. As the work progresses the executives plot a single line upward. At the beginning of the next month a new blueprint goes out, projecting the job ahead 30 days.

Such a delay as that shown here in the delivery of stone, calls for an explanation from the purchasing agent. That delay, of course, was responsible for retarding the operations that followed.

This chart, like all the other plans described here, makes a delay prominent. And that, after all, is the most that any inanimate method can be expected to do. A schedule will not do the work. The man on the job has to do that.

How the Problem of Filing Drawings Vertically Has Been Solved

Many attempts have been made to devise a satisfactory vertical file for tracings and blueprints. But to hold flexible sheets perfectly flat, to remove and replace them without crumpling in a vertical file, proved a much more difficult feat than was anticipated. However, the problem has been solved in a simple but ingenious manner by C. B. Ulrich, as shown in the accompanying illustration.



Vertical File for Tracings and Blueprints.

Fig. 1—Sectional view of Plantile showing how springs provide compression. Fig. 2—Showing principle of compression, nine springs being represented by nine pairs of hands. Fig. 3—Cross section of Plantile pocket and folders on line AA, showing folders containing tracings, held in vertical position by springs.

The Springs Act Like Hands.—If a large tracing were placed in a stiff paper folder, and if nine pairs of hands were to press on opposite sides of the folder (Fig. 2), it is evident that the tracing would be held perfectly flat and would not crumple when raised or lowered vertically. If nine pairs of coiled springs were substituted for the hands (Fig. 3), the effect would be the same, reasoned Mr. Ulrich, and upon testing his theory he found it to be correct. So he designed a vertical file case, as shown in Fig. 1, based on the continuous pressure principle just described.

A vertical filing case 44 in. high, 52 in. long and 30 in. thick holds 6,000 tracings. To accommodate the same number of tracings in drawers would require a stack of 30 drawers rising to a height of 9½ ft., or to the ceiling of an ordinary room. Since it is very inconvenient to have a filing case of such a height, it is customary to have one about 4 to 5 ft. high; thus occupying twice as much floor space as with the Ulrich vertical file.

The manufacturer gives the following 15 reasons in favor of using Ulrich vertical files:

1. Saving of 33⅓ per cent to 50 per cent floor space.
2. Costs from 65 per cent to 95 per cent less than plan drawers subdivided.
3. Greater protection against fire than any other case on the market.
4. Absolute protection against water in case of fire.
5. Better classification of drawings by use of folder.
6. Drawings easily and quickly located.
7. No climbing or stooping, as operator always stands on the floor.
8. Better light and ventilation in filing room on account of less cubical space occupied.

9. Weight on floor is 50 per cent less than if steel plan drawers are used.

10. Drawings kept perfectly flat and smooth. No jamming or crushing.

11. Twenty-four-inch space is all that is required to operate the Planfile. Plan drawers require from 30 to 40 in. for aisle space for drawings 48x36.

12. Index always in sight when file is being operated.

13. Does not require a mechanic to move cases when you desire to rearrange file room. Planfiles roll on casters.

14. Spring compression holds drawings vertically and prevents wear on tracings, as they are handled in large folders same as letters.

15. Locking of one Planfile protects from 4,500 to 5,000 drawings. Necessary to lock 25 drawers to accomplish same result.

These filing cases are made in several sizes by the Ulrich Planfiling Equipment Co., Jamestown, N. Y.

Removing the Distrust of Piece Work*

F. A. CARLISLE,

Manager, Friedlander-Brady Knitting Mills, Chicago

Three Causes of Distrust.—That straight piece work, or for that matter any other system of wage payment differing from the method in use, is immediately looked upon with suspicion by the worker as a means of his exploitation, is attributable to at least three primal causes:

1. We are creatures of habit and dislike intensely to be disturbed from present practices, bad though they may be. There is also the undefined but natural fear which we all feel of that which is new and not thoroughly understood.

2. It is entirely possible that the operator or some of his close friends have suffered at some time from rates that were carelessly set and mercilessly cut when their glaring inconsistency was demonstrated. It is little wonder that confidence is hesitatingly given.

3. There exists a widespread and insistent propaganda, emanating from certain labor organizations and socialistic sources, that capital is inherently criminal and exists only for the oppression of the worker; that any move of management is only to further this end and must be fought whether understood or not.

There may be other causes, but these are enough to show that complete and lasting success is more apt to be attained if the worker is as carefully considered as his machine, and if effort is made to secure his co-operation and approval.

What Is Necessary.—It is the opinion of some that the operator is, technically at least, a partner in production and that between partners there should be no secrets or sharp practices. It is not imagined that all operators will be won over at once, but that a certain number can be reached through their reason.

Their approval should be gained to at least three essential propositions:

1. That a man is entitled to reward commensurate with his skill; that the careless and the indolent should not penalize the efficient.

2. That his interests and his employer's interests are identical; that which injures the one will injure the other.

3. That he will discuss all misunderstandings frankly with the management or its representative before passing judgment on decisions relating to him.

These views may be taken up with some known leaders of the workers, or better still, in smaller organizations by mass meetings, or in larger plants through the medium of house organs.

It must be shown—

That the company will profit by stabilized costs,

That the operator will profit by increased earnings commensurate with his skill and effort.

In concerns or departments where piece work is to be introduced the methods to be employed in computing rates should be explained to the operators and the work started with a few simple rates which will demonstrate just what is contemplated and just what earnings will be possible.

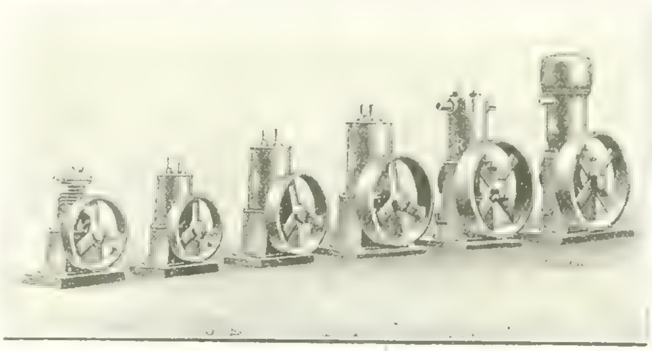
Once it is demonstrated that justice and fair dealing are to be rigidly practiced and that higher earnings are possible without additional effort on the part of the industrious, the opposition of those who cannot or will not be influenced by reason will gradually recede.

Confidence is the foundation of successful piece work practice, upon which must be built continuously justice, co-operation, skill and accuracy.

Without these piece work practice will have a deservedly hard road to travel.

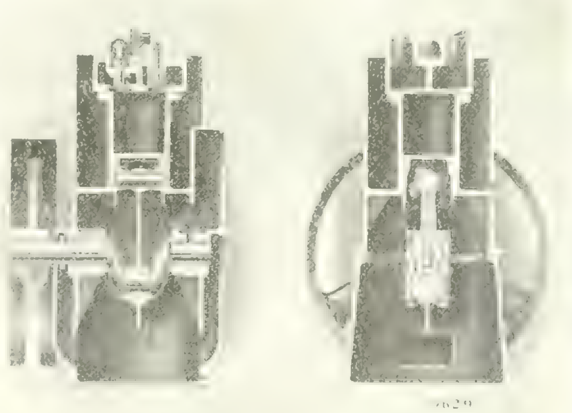
Small Air Compressors of 3 to 45 Cu. Ft. Capacity

When, in the emergency at the outbreak of the war, there was a sudden call for a large number of small air compressors for service where reliability was imperative, the Ingersoll-Rand Co.'s offer to produce for immediate use the Imperial Type 14 compressors which it had just completed testing out and had adopted as its new standard small compressor type, was accepted. The field performance of these built-on-hurry-order machines was watched with critical eye, but after a year's service their record was clear. They had proven themselves efficient, reliable, and inexpensive to operate.



Type 14 Compressor—2¾ x 3 Air Cooled; 3½ x 4 Water Cooled; 4½ x 5 Water Cooled; 6 x 6 Water Cooled Group.

These little machines have now been placed on the general market. There are four sizes and the capacity range runs from 3 to 45 cu. ft. per minute at pressures to 100 lb. per square inch. The small compressors can, however, be used for pressure requirements up to 200 lb. per square inch, the horsepower needed being, of course, slightly increased. They are single acting machines of the vertical type built for belt drive. Where driven from line shaft, tight and loose pulleys are supplied; where the use of independent motor is planned they are ordinarily furnished as a unit complete with motor, endless belt and short drive attachment. In the latter case a hardwood base plate is included with the standard equipments,



Section of Imperial Type 14 Compressor.

The machines are so well balanced as to operate satisfactorily if bolted to any solid flooring, but where permanency of installation is desired the building of a concrete foundation is advocated. The smallest size is built with

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*From 100% Magazine

[illegible] for air cooling where the service is intermittent [illegible] of the reservoir type for continuous operation. [illegible] machines are water cooled only, employing the reservoir jacket system except that, in the case of the largest size, a closed jacket for connection to pressure system is optional. In this connection it is worth noting that the reservoir cylinder design affords unusually ample water capacity and that both cylinder barrel and head are cooled. The manufacturer states that a single filling of water space will suffice for a 10-hour day's run.

Cutting Old Mine Timbering with Jackhamer

In mining a [illegible] through old caved squareset stopes at the Kendall mine, Kendall, Mont., considerable timber was encountered. The work of chopping this out with an ax, in addition to the blasting that was necessary, impeded progress, but the delay was overcome by the use of a Jackhamer drill and a special chisel bit. The methods employed in the work are described in the Engineering and Mining Journal by Mr. Frank B. Bryant. A piece of jackhamer steel 18 in. in length was drawn and flattened at one end to the shape of an ordinary wood chisel. The bit was 2 in. wide at the cutting edge, which tapered back to a thickness of ⅜ in. at about 1 in. from the edge. The shank of the bit was ground round so that the chuck would not grip it; therefore, there was no rotation of the bit. This was used in cutting off lagging, plank, and ends of timber, and by chipping, after the manner in which an ax is used, it was possible to cut through 14-in. timbers in a short time.

Railroad Deficit of Nearly $133,000,000 for First 3 Months of 1919. A deficit of about $133,000,000 in Government operation of the railroads during first three months of the year is indicated by the March reports to the Interstate Commerce Commission. The January deficit was $37,820,000; that for February, $37,828,000; and that for March, $57,327,000. Freight traffic during March fell 23.2 per cent below a year ago, as compared with a decline of 13.5 per cent in February, and a 10 per cent gain in January. Eastern roads failed in March to earn any net operating income. Their deficit was $1,283,000. The Southern roads earned $4,489,000 and the Western roads $7,719,000. The three months' net operating income for Class I roads, including switching and terminal companies, was $39,813,000, as compared with an average of $172,798,000 during the three years prior to the assumption of Government management. Director General Hines has figured the aggregate deficit during the first three months at $176,166,065. He urges that any change rates to remedy this situation be deferred until more stable conditions prevail. He looks for a resumption of business later in the year as an alleviating circumstance.

Breaking Up of Concrete in Track Foundations with Dynamite. The Harrisburg Rys. Co., Harrisburg, Pa., on several occasions has used dynamite for breaking up concrete in the foundations of street railway tracks. The method of doing this is described in Aera by Mr. D. B. Moist, Engineer of the company.

The concrete was about 12 in. thick, and of such a quality that it was almost impossible to break it up by means of sledges and pins. Five 1-in. holes were drilled across the track parallel to and between the ties, to a depth of about 8 in. The drilling was done with a jackhamer type air drill. After a length of about 15 ft. of track had been drilled, the holes were loaded with about ¼ stick of dynamite and an electric exploder. The holes were then covered with a rope mat and exploded. The concrete could then be asily removed by pick and shovel methods. No cost data of this method are available, but Mr. Moist believes the method is justifiable where the concrete to be removed is hard and the size of the job is not sufficient to justify a more elaborate outfit.

News Letter

St. Louis Items.

Ward Bros., 1257 E. 125th St., Cleveland, Ohio, have 40,000 yd. of grading at Akron, O., to sublet. Will furnish machine and engine if necessary.

C. A. Samuelson, 557 W. 29th St., Indianapolis, Ind., came in the other day looking for work for Johnny McInerney's outfit which consists of 14 teams, machine, wagons and wheelers.

We are in receipt of [illegible] circular announcing the removal of the [illegible] of the Steam Shovel and Dredge Journal from [illegible] to Washington, [illegible]. [illegible] Langston continues as editor and manager.

[illegible] of the C. R. Cummins Co. was with us a couple of days last week. He told us that the C. R. Cummins Co. have a couple of [illegible] level outfits idle at the present time that they would like to put to work immediately. Address them Leader News Bldg., [illegible], O., or write [illegible] P. O. Box 223, Terre Haute, Ind.

[illegible] C. Dunn of Dunn & McCarthy narrowly escaped serious injury in an automobile accident here on May 8th when a machine in which he was riding was hit by another that was just turning a corner on [illegible] Ave. and Natural Bridge road. Although both cars were badly damaged Dunn sustained only a bruised shoulder as a result of the accident. Dunn remarked after the accident that it was just luck that kept him from being the main attraction in a funeral procession. The writer hopes for his early recovery and hopes to be able to spend a few more pleasant years with his old friend before any procession starts.

Personals

Karl R. Kennison has been transferred from the Middle Atlantic District to be assistant district plant engineer on the Southern District, Emergency Fleet Corporation, with office in New Orleans.

Oliver G. Shafer and **Robert W. Hanson** have entered into a partnership under the firm name of Shafer & Hanson and will engage in a general contracting business with offices at Caldwell, Ohio.

Lieut. William H. Collins of Decatur, Ill., has been appointed civil engineer in the office of the Illinois Public Utilities Commission. Prior to his enlistment Lieut. Collins was assistant city engineer of Decatur.

J. O. Walker, division engineer of the Atlantic Division of the N. C. & St. L. Ry., after 33 years continuous service, 28 of which were spent with the Nashville, Chattanooga & St. Louis Ry. and leased lines, has been retired. He will make his future home in Atlanta.

D. C. Fenstermaker, assistant engineer in charge of construction on the Chicago, Milwaukee & St. Paul Ry., has been promoted to district engineer, with headquarters at Chicago, in charge of the Iowa, the Des Moines, the Kansas City, the Sioux City and Dakota and Dubuque divisions, succeeding W. E. Wood, assigned to other duties.

W. R. Armstrong, heretofore engineer maintenance of way of the Union Pacific R. R., has been appointed assistant chief engineer of the Oregon Short Line to succeed the late Carl Stradley. Mr. Armstrong's place on the Union Pacific will be taken by R. B. Robinson, engineer in charge of right of way maintenance on the Oregon Short Line.

E. W. Hammond, division engineer of the Buffalo, Rochester & Pittsburgh R. R., with office at Du Bois, Pa., has been promoted to acting engineer maintenance of way, with headquarters at Rochester, N. Y., vice G. C. Cleaver, granted leave of absence, and J. B. Oatman, roadmaster, at Du Bois, has been promoted to acting division engineer, with headquarters at Du Bois.

Z. A. Woods, divisional superintendent of the New Orleans & Northeastern R. R., has been appointed chief engineer of the Southern R. R. System to fill the vacancy caused by the death of Curtis Daugherty. Mr. Woods has been connected with the Southern railway in the engineering and traffic departments since he was a boy and for the last three years was divisional superintendent with headquarters in New Orleans. Shortly after the government assumed charge of railroads the headquarters of this division of the Southern was removed to Hattiesburg. Mr. Woods will hereafter maintain his office in Cincinnati.

R. W. Spofford has been appointed local general manager of the Manila Electric Railroad & Light Co., Manila, Philippine Islands, by The J. G. White Management Corporation, New York, N. Y., the operating managers of that company. Mr. Spofford was graduated from the United States Naval Academy at Annapolis and spent about 5 years in the navy. He was retired in 1911. Shortly thereafter he was engaged by The J. G. White Management Corporation and was assigned to the staff of the Augusta-Aiken Railway & Electric Corporation, Augusta, Ga., and later was made general manager of that company. When the United States entered the war, Mr. Spofford, as a naval reserve officer, was called to the colors for service. With the signing of the armistice he was [illegible] retired out of the navy with the grade of lieutenant-commander.

Industrial Notes

The McMyler-Interstate Co., Cleveland, O., has opened an office in the [illegible] Bldg., Seattle, Wash., to cover Washington, Oregon and [illegible]. [illegible] Hendry is in charge.

The Bell Locomotive Works, Inc., 11 Pine St., New York City, announces [illegible] J. Stanley McCormack will return [illegible] old position as soon as he receives his discharge from the Naval Aviation Corps. Mr. McCormack enlisted at the outbreak of the war, received his commission, training as a naval [illegible] to special experimental aviation [illegible]. His discharge is expected by June 1.

George A. Harter has been elected president of the Central Foundry Co. and its subsidiary companies. Mr. Harter is president of the Essex Foundry Co. of Newark, N. J., and has long been an important [illegible] fittings industries. He is the son of Victor A. Harter, deceased, who controlled for many years the Monitor Iron Works of Newark, which for some 20 years has been one of the units of the Central Foundry Co.

The Equipment Corporation of America, Lumber Exchange Bldg., Chicago, has moved its Pittsburgh office to larger quarters in the [illegible] Bldg., where H. Grant Lorain is district manager, assisted by [illegible], who was with the Emergency Fleet Corporation up to May 1, in the shipyard construction department. Previous to the war Mr. Lorain was for 10 years associated with the Leschin Rope Co. in the Pittsburgh district. The Philadelphia office is now located in Land Title Bldg. and District Manager Whitehead has increased his office and sales organization. Alfred Rennolds, associated with Mr. Capron for the past 8 years as field salesman in the Chicago district, has been made Chicago district manager.

Building and Structural Issue

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The *articles* in the first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering and contracting field. The *articles* in the first and last issues of each month (1st and 4th Wednesdays) completely cover county engineering and highway engineering and contracting. The *articles* in the third and last issues of each month (3rd and 4th Wednesdays) completely cover steam and electric railway location, design and construction. See the "mast head" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation and Dredging (c) Quarries and Pits
(b) Rivers and Canals (d) Railways, Steam and Electric
(e) Management and Office System

Buildings and Structures—4th Wednesday
(a) Buildings (c) Harbor Structures
(b) Bridges (d) Miscellaneous Structures
(e) Properties of Materials

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The Past and Prospective Rise of Wages in the Building Trades

The cost of labor of erecting buildings has usually ranged from 30 to 50 per cent of the total cost, depending on the locality and the character of the building. In fireproof buildings the labor has probably averaged about 30 per cent, whereas in frame buildings the average has been about 40 per cent.

Statistics given elsewhere in this issue show that building materials have risen about 84 per cent, on the average, since the world war started. Lumber has risen about 73 per cent. The average increase in price of the 313 commodities given in Dunn's index has been 113 per cent.

No statistics are yet available to show the average rise in wages in the building trades, but it is safe to put it at not less than 30 per cent, and probably about 40 per cent. The rise of wages in New York City building trades is given elsewhere in this issue, and the average increase is about 40 per cent.

If we assume an average 40 per cent increase of builders' wages and an average 80 per cent increase in the cost of materials, and if we assume that for each dollar of wages there is spent $1.50 for materials delivered, then the average increase in the cost of buildings is 64 per cent since 1914.

Statistics from various sources indicate [illegible] rents will surely go much higher. Probably they will rise fully 50 per cent above what they now are. Average freight rates have gone up 35 per cent, and must be raised another 1[illegible] per cent as was shown [illegible] to meet the deficits that the railways are now incurring.

These, and other factors, make it clear that wages in the building trades will rise fully 25 per cent within the next few years. The unions will probably not attempt to secure higher wages until there is a much greater volume of building under way than at present. But let no building contractor, engineer or owner make the mistake of thinking that the building trades unions will not fight for further substantial [illegible]

Since average prices [illegible] short sighted people [illegible] stantial drop in such [illegible] turing trades have risen more than in the building trades. Thus [illegible] tory the labor cost of [illegible] per cent, and coal for [illegible] per cent [illegible]

28 Pages = 40 pages

The 28 pages of articles in Engineering and Contracting contain as many words as 40 pages of the size and typography commonly used by other engineering periodicals. Ours is the same size of type and type-page as that of The Literary Digest—easily read, yet giving a large volume of reading matter per page. Our 28 pages of articles would fill 112 pages of the standard 6x9 in. text-book. It would take 10 such books of 580 pages each to hold all the articles printed each year in Engineering and Contracting, to say nothing of our weekly construction news.

[illegible] industry of the Pacific Coast in 1914 was [illegible] in 1918 it was [illegible], an increase of 80 per cent. [illegible] period [illegible] 79 per cent. Wages constitute [illegible] per cent of the [illegible] Douglas fir [illegible].

In [illegible] North Carolina [illegible] per hour in 1914, as against 48 cts. in 1918, [illegible] of 77 per cent.

[illegible] contrasted with those [illegible] remembered that the U. S. [illegible] raised the wages of the average railway employe 84 per cent, that the U. S. Steel Corp. has increased its average wage rate more than 100 per cent, that Swift & Co., the great Chicago packers, have raised their wage rates 125 per cent, and, finally, that there is 55 [illegible] per capita than there was before the war.

[illegible] in money per capita is one of dominant importance. Taken in connection with a broader [illegible] this great increase [illegible] the permanency of high wages and high prices.

[illegible] the building trades will go higher, and prices [illegible] materials will not fall. Slowly, and often reluctantly, engineers, architects, contractors and other business men have been coming to this conclusion during the past six months.

Some Economic Ignoramuses in Congress

[illegible] Herbert Spencer's essays is one in which he shows up the ignorance of members of parliament as to economic matters of the simplest sort. Although that essay was written about half a century ago and related to English legislators, it is applicable today to most of our American congressmen.

A few weeks ago, for example, Senator La Follette delivered a speech (see Congressional Record, p. 2,052, etc.) in which he said:

"Now take pig iron, Mr. President. In bessemer pig iron that costs $12.10 to produce, the labor cost is 73 cents. This is the part that labor plays in the production.

"A ton of pig iron that sold in 1912 for $12.10 had in it as a part of the cost of producing it, 73 cents of labor. The balance was made up of $6.10 cost of iron ore; $3.28 cost of coke; 43 cents cost of limestone; 10 cents cost of steam; 13 cents cost of materials for repairs and maintenance; 12 cents cost of supplies and tools; 24 cents cost of miscellaneous work expense; 18 cents cost of relining and renewals; 3 cents for contingent fund; and 76 cents for general expense and depreciation."

The 73 ct "labor cost" of which Senator La Follette speaks is merely for the labor of converting the raw materials into bessemer pig. Buried in nearly every one of the 10 other items that he enumerates is a labor cost. Take the $3.28 for coke, for example. In that is the cost of labor of mining the coal, transporting it to the ovens, coking it, hauling by rail to the furnace, etc. In fact, almost the only part of this $3.28 cost that is not for wages or salaries is the interest and profit on the plants used in producing and handling the materials. Even taxes on the plant are mainly consumed in paying wages and salaries of government employes, among whom is Senator La Follette himself. Similarly as to charges for depreciation on the plant; for the main cost of renewing any part or all of a plant, is in its ultimate analysis, a labor cost.

[illegible] estimated by some economists that of the entire annual income of all Americans, now totaling some 50 billion dollars, fully 70 per cent is ultimately paid out in wages and salaries. A large part of the remaining 30 per cent is doubtless an indirect payment for services. We have just mentioned taxes as being, for the most part, payments for services. Even "profits" are largely payments for services. This is clearly seen in the case of small merchants and other "middlemen," whose entire profits usually amount to only a moderate salary for services rendered to their customers.

All this is elementary economics, but many a congressman beside Senator La Follette has shown just his sort of ignorance of economic principles. It is to be hoped that congress will ultimately consist mainly of trained, practical, econom[illegible] until trained [illegible] become trained thinkers there will continue to be [illegible] a pulsator and a paucity of [illegible].

Why Engineers Should Be Habituated to Seek and Memorize Useful Facts

[illegible] usually been led to think that it is rather reprehensible to commit either facts or fancies to memory. Learning "by heart" has become taboo in the schools. Even the multiplication table must not be memorized. All this because "parrots merely memorize," ergo memorizers are merely parrots. Unanswerable syllogism!

[illegible] are supposed to have learning by reason, but do we have better reasoners? Instead of studying the details of practice students are told to concentrate their attention upon principles and let the details be learned as they may. Even in our engineering colleges, where we expect to find practice wedded to theory, there has been a growing reverence for "principles" and "theories" coincident with a waning regard for details of practice. Has this resulted in a better brood of engineers? Consider the question seriously.

In the laudable effort to train students to become better thinkers, has not sight been lost of two facts? First, that errors in thinking are more often attributable to lack of pertinent facts or data than to false processes of reasoning. Second, that the habit of gathering and analyzing data is not more readily acquired without the assistance of a teacher than is the habit of drawing correct inferences from the data. Correct thinking becomes habitual through practice under a good teacher. But how many teachers fully appreciate the corelated fact that the systematic collecting and analyzing of data—"mere details"—seldom becomes habitual except through training during one's youth?

Why is it that so many men reason fairly well, yet never reason well enough to become leaders of other men? Is it because they lack push, persistence or pull? While at least two of these three p's are important, we incline to the belief that the commonest cause of failure to advance is pure ignorance—ignorance of the methods used by those who are most successful. Yet in this age of printing ignorance is usually traceable to the absence of studious habits. A studious man can find in magazines and books an enormous number of methods used by successful men.

Most men are not studious. This holds true not only of those in the lower walks of life, but in the higher walks. It holds true of most college graduates. It holds true of most college professors. The man who systematically searches without ceasing for better methods is a rare man. Yet systematic searching is a simple matter. The trouble is that it is so simple that few teachers have realized the importance of training students to be systematic searchers.

Every youth should be trained to search for facts, and the training should be so thorough and prolonged that the fact-searching habit will cling for life. Furthermore, everyone should be taught to memorize a great mass of facts relating to his trade, business or profession. One of the great educational mistakes of the past 25 years or more has been the failure to train fact-searchers and fact-memorizers.

Not only should facts be sought and analyzed, but many of them should be committed to memory, wholly or in part. Engineering students have been encouraged not to memorize details, but merely to learn where to find them. This has been a gross mistake. It has not only tended to breed a lazy mentality, but it has given a false feeling of ability to "cram up" on a moment's notice so as to solve any given engineering problem. All the engineering books on any subject contain only a small fraction of the useful data and details relating to it. Few indexes of books and no indexes of magazines are satisfactory. Magazine literature is too voluminous to be even thumbed through for a period of years without many days' labor. Yet "cram-it-up" engineers and they constitute the majority blithely scan a few books and a few magazine indexes, get some data and work you out an answer while you wait, quite unconscious that it is probably a wrong answer. In engineering, be it remembered, any answer is wrong if it does not yield the most economic result obtainable in our present state of knowledge.

Why Engineers Should Understand the Economics of Contracting

With each $1,000 of cash a building contractor can [illegible] $5,000 to $10,000 worth of work. Engineers and architects seldom appreciate the economic significance of this fact, for most contracts are so drawn as to require far more capital for their execution than is necessary. For example, payments on account are made monthly, where they usually should be made semi-monthly; and the payments are never made for the full amount of work done. All of the contractor's profit, and often more, is held up till the final payment—a wholly unnecessary procedure if either the bond [illegible] contractor is "good."

If every engineer were first a contractor before practicing engineering, there would be fewer contracts that add unnecessarily to the financial burdens of contractors. But the average engineer is so concerned with protecting his client's interest, and so innocent of knowledge of the economics of contracting, that he makes contracts unduly burdensome and correspondingly expensive for his client.

A bond for a public contract is necessary, as laws now are, but it would ordinarily be quite as effective if made for 20 per cent of the contract price as for a larger percentage. A bond for a private contract is usually not needed at all, if the engineer knows his business; for, in the first place, he will invite none but reliable contractors to bid, and, in the second place, he will O. K. the final payment only after receiving waivers of liens on the property from all who have furnished materials.

Only the other day a large contract for a group of industrial buildings was let on which the contractor had to pay $10,000 to a surety company for the bond. The bond was for the full amount of the contract. By that piece of ignorance the engineer made that work cost the owner just $10,000 more than it need have cost.

Few designing engineers have had experience as contractors, but there is, nevertheless, no excuse for ignorance about the cost of bonds. There is scarcely more excuse for not knowing that frequent payments enable a contractor to handle more work with his capital, thus reducing his overhead costs.

Mr. Hines and the Price of Steel

In January, 1913, iron and steel industries were enjoying moderate prosperity. During the war steel prices rose about 85 per cent. They have recently been reduced about 15 per cent to stimulate trade. The following are present prices and prices in January, 1913:

[illegible]

Director General of Rys. Hines refused, several weeks ago, to pay $47 a ton for rails, although that was a price agreed upon by the steel manufacturers and the Industrial Board. He then called for bids on 200,000 tons of rails, and has just accepted a bid of $47, although still protesting that it is too high.

Director Hines undoubtedly thinks a 70 per cent increase in rail prices is too much, but the men who meet the payrolls of the steel mills seem to have the better of the argument. They contend that the recent reduction of 15 per cent in steel prices was all that could be borne, and they intimate that steel prices will rise again as soon as latent demand is converted into active demand. Who is likely to be better informed as to steel costs, Mr. Hines, a buyer of steel, or the companies that make steel and pay wages twice as high as they were before the war?

Mr. Hines' refusal to pay the $47 price fixed by another department of government has caused a great deal of adverse criticism. Not only has he held up railway construction and maintenance, but his policy of waiting has been followed by other buyers of steel who now find that they were misled.

Looked at from a broadly economic view, Mr. Hines should have placed orders for steel rails months ago, even though he regarded the price as being too high. The pressing economic need then was, and still is, to give employment to men. But Mr. Hines took a very restricted and short sighted view, hurtful not only to the steel mills and the railroads, but to industry in general.

Surface Area Method for Proportioning Aggregates

[illegible] tures," in your issue of April 22, 1919, contains much infor[illegible] the construction of concrete structures. However, the reference to the surface area method of proportioning appears to the writer to be subject to question, more especially so since his own investigations have shown its efficiency for both laboratory and field use.

[illegible] "Our studies have shown that surface area is not a satisfactory basis for proportioning aggregates." Since the surface area method is not confined to the proportioning of the aggregates, but instead is adapted to the proportioning of all the ingredients of the mix, including the water content, Table II of the article above mentioned does not appear to the writer to offer evidence tending to disprove the fundamental principles of the surface area method, but rather to add emphasis to the important role of the water content of the mix in the determination of the ultimate strength of the concrete. Incidentally Table II calls attention to a rather important detail of concrete making to which the fineness modulus method gives scant consideration.

Granting for the present, the correctness of the surface areas, as recorded in Table II, then, since the quantities of cement and water were maintained as constants throughout the entire series of tests, it naturally follows that, by reason of the variations existing in the surface areas of the aggregates to be moistened, the quantity of water combining with the cement to form the cement matrix is correspondingly changed. Very small variations in the water content of the cement matrix, at the time of mixing, produce radical changes in its strength, and other physical properties when it has become fully set. "However, it is only the water which goes to the cement (that is, exclusive of absorbed water) which affects the concrete strength." Likewise this change in the consistency (plasticity) of the concrete is fully recognized in Bulletin No. 1, Lewis Institute, from which your article was taken, but this portion of the original paper was not incorporated into the Engineering and Contracting article. Its importance appears to justify its inclusion here:

"The grading of the aggregate may vary over a wide range without producing any effect on concrete strength, so long as the cement and water remain unchanged. The consistency of the concrete will be changed, but this will not affect the concrete strength if all mixes are plastic." The requirement that the concrete be "plastic" when mixed will be referred to further on. However, it may be said here that the above quotation together with the preceding one from the same source contain the kernel of the cement water ratio idea.

Concerning the surface areas recorded in Table II, the writer has endeavored to check about one-third of the entire list. For this purpose unit areas, adapted to Tyler standard sieves, were used. These areas were derived from the writer's tests described fully in a paper "Proportioning the Materials of Mortars and Concretes by Surface Areas of Aggregates." (See Proceedings, American Society for Testing Materials, Vol. XVIII, Part 2, Page 235.) The fact that a very marked difference has been found between his results and the tabulated areas leads to the conclusion that the latter were determined by a somewhat different method.

Table II shows the following characteristics of the fineness modulus method as applied to the series of tests therein described. The general characteristics of the surface area method are here given for purposes of comparison:

[illegible] oughness [illegible]

For a proposed concrete structure the consideration of possible sources of supply of aggregates frequently involves the laboratory examination of the concrete making qualities of two or more different aggregates varying in their sieve analyses and other physical properties. The field conditions [illegible] as well as the ultimate strength, toughness, etc., of the concrete. [illegible] that the relative [illegible] to differences under the conditions characteristic of the surface area method. Most assuredly those conditions which tend to produce variations in the relative plasticity and the final strength of the cement matrix should be eliminated. In the tests described in Table II, uniformity of strength was the single object sought. Uniformity of plasticity and of toughness were not considered.

The writer does not desire to create the impression that the fineness modulus method is radically different from the surface area method: on the contrary he has failed to discover wherein these methods are at variance, although it may truly be said that they approach the problem of concrete design from quite different angles.

I take this opportunity to express my sincere appreciation of the valuable discoveries made and the work performed at Lewis Institute under the direction of Prof. Duff A. Abrams.

LLEWELLYN N. EDWARDS.

Supervising Engineer of Bridges, Department of Works.
Toronto, Ontario.

Method for Designing Concrete Beams Reinforced for Compression

To the Editor: Mr. Raymond's article on "A Simple Method for Designing Concrete Beams Reinforced for Compression" in Engineering and Contracting for April 23, 1919, is interesting and his method is, I think, quite widely used. The method of Thomas and Nicholas in "Reinforced Concrete Design Tables" is very similar and by use of the tables the required computation for the individual problem is materially less than by Mr. Raymond's solution.

For example, considering Mr. Raymond's Illustrative Problem of a beam 10 in. x 24 in. with a moment of 800,000 in.-lb. and $f_s = 16{,}000$, $f_c = 650$, $n = 15$.

From tables for 22-in. depth and 12-in. width—

Allowable, M = 52,000 ft.-lb. As required, 2.02 sq. in.

$$\text{Hence for 10-in. width } M = \frac{10}{12}\,52{,}000 = 43{,}400 \text{ in lb}$$

$$As = \frac{10}{12}\,2.02 = 1.68 \text{ sq. in.}$$

The balance of the moment to be taken by compression steel is 66,700 − 43,400 = 23,300 ft. lb.

From the tables, 1 sq. in. of compression steel 2 in. down in a 24-in. beam has an allowable moment of 11,520 ft. lb.

Hence $\frac{23{,}300}{11{,}520} = 2.02$ sq. in. the required area of compression steel. The additional tension steel will be $\frac{23{,}400 \times 12}{20 \times 16{,}000} = 0.88$ sq. in. 0.88 + 1.68 = 2.56 sq. in. The total required tension steel.

Four slide rule computations occur in the above solution against Mr. Raymond's six and none of the four are as complex expressions as some of his. Also by the tables T-beams with compression steel are solved as easily as simple beams.

W. W. CLIFFORD.
Structural Engineer.

Hyde Park, Mass.

Time Saving Diagram for Concrete Computation

To the Editor: The accompanying diagram has proved very useful in our work and we are passing it along to the engineer and contractor as a time saver.

Note that dead load is taken care of and that only the live load need be used in taking off the required thickness of slab. Although the formulae for obtaining the proper thickness of slabs are very simple, namely,

$M = \frac{1}{8}wL^2$, or 1/10 or 1/12 and

$M = 107.5BD^2$ for Moment of Resistance

there is the practical difficulty in using them in the calculation of individual problems that "w" cannot be correctly taken unless the correct dead load is known, and an approximation must still be made by taking a value of dead load based either on an assumed thickness of slab or an assumed dead load. One or two approximations will generally give the result. This objection to the formulae does not hold, however, in constructing diagrams where dead load has been included and live loads only are indicated.

Note also that the graph will give results for semi-continuous and continuous slabs by reducing the actual span to an equivalent span by the use of a coefficient and using equivalent span in the graph.

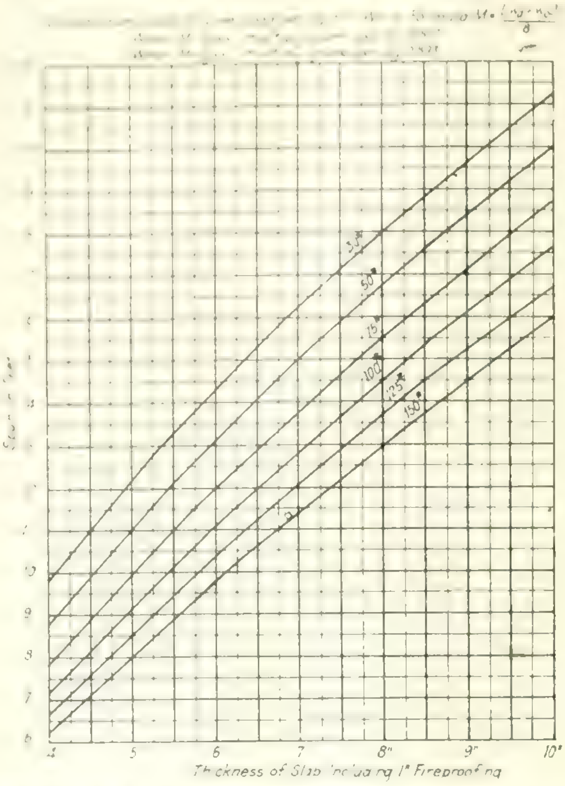

Diagram Showing Thickness of Concrete Slabs in Terms of Live Load.

M. W. SERBY,
William Serby Co., Builders.

Washington, D. C.

Wage Scale in Building Trades in New York City

The accompanying table, prepared from data furnished by the Building Trades Employers' Association of New York City, shows the wage scale of various trades in the building field in that city in 1902 and 1914 and the present scale:

Trades	1902	1914.	1919.
Carpenters (framework):			
Manhattan	$4.00	$....	$6.25
Richmond	[illegible]		6.00
Bricklayers	[illegible]	6.00	7.00
Laborers	2.80	3.14	4.00
Cement [illegible]	1.80		5.60
Engineers (Hoisting Assn.)	[illegible]	6.00	....
Engineers [illegible]	[illegible]	5.00	..
Painters	[illegible]		6.00
Plasterers	[illegible]	—	7.00
Laborers		—	4.50
Metallic lathers	[illegible]		6.00
Electrical workers	[illegible]	[illegible]	6.00
Helpers	2.20		3.00
Plumbers	[illegible]		6.00
Steam fitters	4.50		6.00
Helpers	—		4.00
Stonemasons	—	4.80	.
Cutters	—	5.50	6.75
Setters		6.00	7.00
Mosaic workers		—	5.50
Tile layers		—	6.00
Helpers			[illegible]
Marble cutters [illegible]			6.00
Carvers		6.00	6.50
Roofers (composition)		3.50	4.75
Slate and tile		[illegible]	6.50
Roofers [illegible]		5.00	[illegible]
Housesmiths			
Structural	[illegible]		7.00
Finishers			6.40
Helpers			5.00
Housesmiths [illegible]		[illegible]	5.00
Helpers	2.25		[illegible]

What Shall an Engineer Read in General Literature?

By R. FLEMING,
American Bridge Co., New York City.

Read Plato. Not an entire five or six volume edition, but "The Phaedo," where Socrates is at his best. Of course the adamantine rock of Shakespeare will not be overlooked. Macbeth and Hamlet! Who can do justice in writing of them? But human thought reaches its highest level in two books of the Hebrew Scriptures—Job and Isaiah. If the writer had his way they would be introduced into every college course in English.

There was once a theatrical manager who occasionally gave Shakespearian performances in order, he said, that people would appreciate his other plays. On the same principle, for relaxation from worthwhile books like those mentioned there is nothing like Frank R. Stockton. His stories, clean and full of humor, are a tonic to a weary mind. "Rudder Grange," "The Squirrel Inn," "The Late Mrs. Null" or any of his many volumes, furnish the same restfulness.

"As a rule, Americans never read history and never learn anything from it." This charge, if true, can be easily remedied. Fiske's "The Critical Period of American History, 1783-1789" and Rhodes' "History of the United States from the Compromise of 1850 to the Final Restoration of Home Rule to the South in 1877," are as fascinating as intense novels and should be read by every educated American. Carlyle's "French Revolution" is a masterpiece of historical writing, but a fair knowledge of the history of that stormy period is necessary to thoroughly enjoy it. In some quarters much is made of the historical novel. "Quo Vadis," "Henry Esmond," "A Tale of Two Cities," and "Last Days of Pompeii" are truly great books. "John Inglesant," though not so well known, belongs to the same class.

It is well to read all the writings of one or two authors. Charlotte Bronte and George Eliot may be cited. There is pleasure in reading the books of one or two present-day authors as they come out. In American fiction a choice can be made from such writers as James Lane Allen, Margaret Deland, Basil King or Henry Sydnor Harrison. In Harrison's "Angela's Business" a young engineer is an interesting character. One wishes to dip occasionally into the "best sellers." "The Winning of Barbara Worth," "The Inside of the Cup," "Mr. Britling Sees It Through," "The Four Horsemen of the Apocalypse" have much that a technical man will especially appreciate.

To come now to the realm of poetry. What! Poetry and engineering! Why not? When Alfred Noyes, the English poet, was asked by a reporter, "What place should poetry have in the life of a college student?" he replied, "What place should poetry have in the life of any man?" Commenting upon this reply, a widely known engineer and business man asks, "Why should engineers deny themselves the inspiration which the contemplation of the best thought of man affords? Why should engineers make of themselves calculating machines —automatons clad in khaki?" Few can climb to the mountain peaks of Browning and Tennyson, but many can appreciate the galaxy of poets who have given a name to American letters. There is often pure enjoyment in reading those not classed with the "great" poets. Many gems "of purest ray serene" may be found in the pages of Van Dyke, Lanier, Sill and Timrod. The joy of discovering them will be akin to that expressed by Keats in his glorious sonnet, "On First Looking Into Chapman's Homer."

For a delightful volume of essays turn to A. C. Benson's "From a College Window." What he says "On Growing Older" somewhat reconciles one to the passing of the years. What he says in "Beauty" may be applied to one's reading: "It is better to be individual than catholic, and better to attempt to feed one's own genuine sense of preference than to continue attempting to correct it by the standards of other people."

Little need be said of the engineer's reading in the line of his profession. Our printed engineering resources are so vast that discrimination is necessary in the matter of selection. However, Ruskin's "Seven Lamps of Architecture" should be included.

If a man has a hobby, whether it be the fourth dimension [illegible] on the subject. Its extent will be a surprise to him.

[illegible] field" is the highwater mark of English prose should not prevent another from thinking this distinction belongs elsewhere to "Pilgrim's Progress" for instance. Some years ago from 600 replies to a questionnaire a list was made of the ten most popular short poems. But "The Blessed Damosel" [illegible] favored. Mr. Roosevelt voiced the sentiment of many when he said in [illegible] of the hundred best books or Dr. Eliot's five-foot book shelf I would rush to the nearest newsstand and buy a ten cent detective story. [illegible] depraved tastes the best books for him to read are those that he likes best. Andrew Lang, in his essay, "Adventures Among Books," says: "Young men, especially in America, write to me and ask me to recommend a course of reading. Distrust a course of reading! People who really care for books read all of them." What Mr Lang probably means is that no one's reading should be circumscribed within narrow boundaries. At the same time, it is better to be well acquainted with a few books than to have a superficial knowledge of many. Reading real literature according to some plan is wiser than the desultory reading of mere printed matter.

In conclusion, this homily may be far from ideal in its suggestions, but it has the merit of recording a personal experience.

Umbrella vs. Butterfly Sheds for Railway Stations

The average pre-war cost of the umbrella or butterfly type of sheds, according to a committee report submitted at the last annual meeting of the American Railway Engineers' Association, was $1.10 per square foot, exclusive of the paving and curb. The average height from curb to eaves was 16 ft. The average spacing center to center of supports was 30 ft. The above average price covers the cost of various types of sheds, including the following features:

(1) Steel supporting structure covered with wood sheathing and composition roofing. (2) Frame supporting structure covered with wood sheathing and composition roofing. (3) Pre-cast concrete columns and roof slab covered with composition roofing.

The committee states that there is no choice between the umbrella shed and the butterfly shed, so far as protection from the elements is concerned, the edge of the gutter being in the same relative position on both types.

Where no waiting room is provided in connection with umbrella sheds, the committee recommends that partitions be built between supporting columns; these partitions to be located at every third bay where traffic is heavy, and every fifth bay where traffic is light. With the umbrella shed type, two gutters and two leaders from the gutters to the central post are necessary. With the butterfly type no gutters are required. This eliminates the first cost for gutters and means lower maintenance cost on account of the lack of same.

Some railroads use circular supporting columns for butterfly type, making use of this column for the regular down spout. On account of the prevalence of cinders the drains at the bottom of the columns are likely to be stopped up and in cold weather the columns will freeze and burst. In either type of shed it is recommended that at or below the platform level of the down spouts a trap with clean-out be installed. It is considered preferable to place the down spouts outside the supporting column.

At umbrella sheds in some parts of the country snow co[illegible] off. Consideration should be given roofing sheds in such lo[illegible] roof is easily ruined by laborers digging into it with picks and shovels removing snow and ice.

The conclusions of the committee were:

In that part of the country where heavy snow occurs umbrella type of shed is preferable, though somewhat more expensive in first cost.

In that part of the country where heavy snows are not a [illegible]

Pneumatic Caissons with Wooden Cylinders for Sinking Bridge Piers

Pneumatic caissons differing somewhat from those generally employed were used in the construction of piers for three bridges now being built under the plans of Harrington, Howard & Ash, Consulting Engineers, Kansas City, Mo. One of these bridges is being built over the Arkansas River near Merrilton, Ark., for the Conway County Bridge District; the second is over the Red River at Texarkana, Ark., the Red River Bridge District being the owner, and the third, over the Canadian River at Eufaula, Okla., is being built for the Jefferson Highway Bridge Co.

The Arkansas River bridge includes a swing span 370 ft. long, three spans 256 ft. long, and one span 164 ft. long. The superstructure is composed of second-hand railway spans which were bought complete.

The bridge over the Red River includes three fixed spans 200 ft. long, two fixed spans 164 ft. long and a lift span 204 ft. long. The three 200-ft. spans are second-hand highway bridge spans which were formerly across the Kaw River at Central Ave., Kansas City; the other three spans are made up of second-hand railway trusses combined with new floor beams and stringers and new laterals to provide the proper width between trusses.

The Canadian River bridge is a succession of deck spans 118 ft. long. All three bridges are for highway service only.

The same contractor, the Midland Bridge Co., Kansas City, Mo., secured the contracts for the construction of the substructures of all these bridges. It was thus able to apply the experience in sinking the piers of the Arkansas River bridge, which was started first, to the other structures.

Details of the caisson construction for the piers at the Arkansas River bridge are shown in Fig. 1. The pneumatic caisson of the pivot pier was fairly large, with an octagon 30 ft. on the base, the walls of which consisted only of one width of 10x10 timbers, planking outside and inside. The roof of the

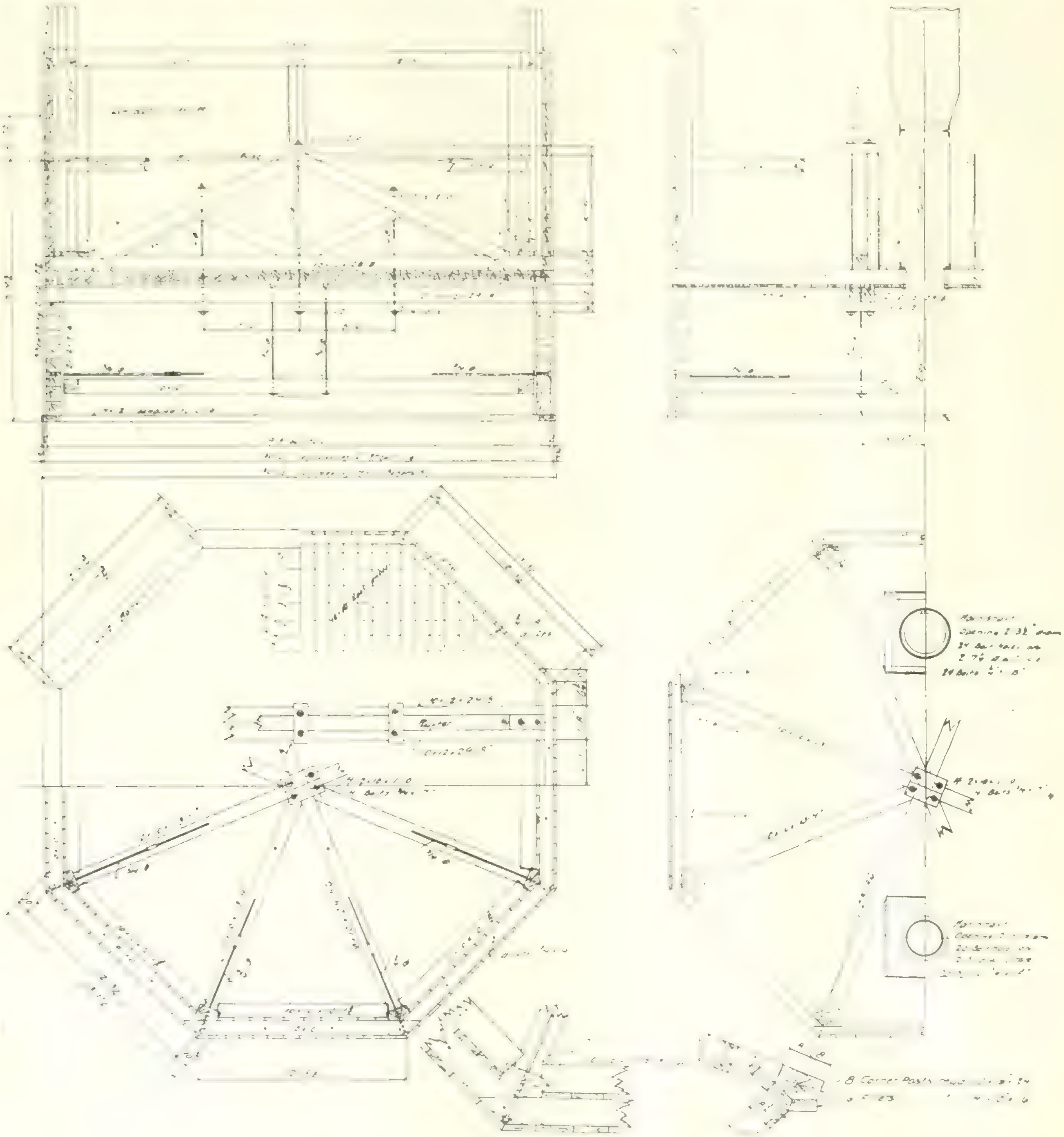

Fig. 1. Details of Caisson Construction for Piers of Arkansas River Bridge.

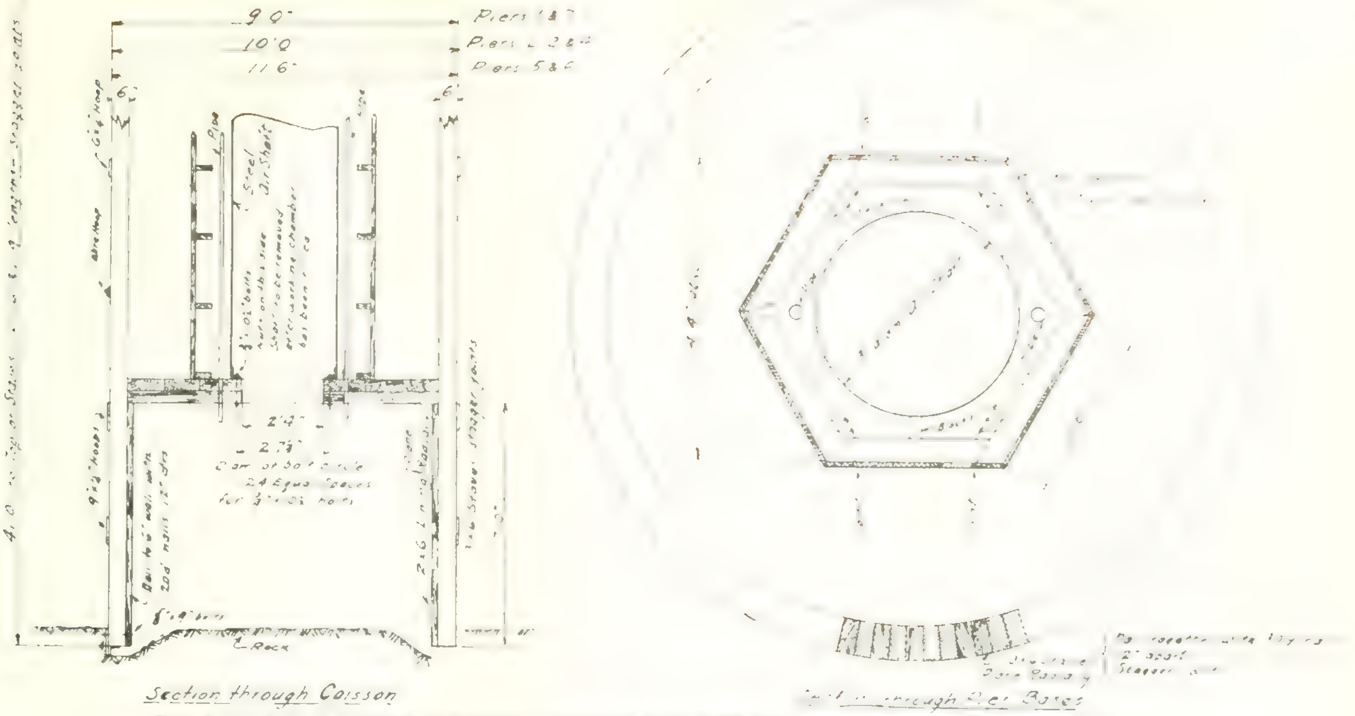

Fig. 2—Details of Caisson and Section Through Pier Base for Red River Bridge at Texarkana, Ark.

working chamber consisted likewise of one layer of 10x10 timbers. To support the concrete above the roof during sinking, there were provided two wooden trusses extending from side to side of the caisson. The shaft was hollow with a 3-ft. reinforced concrete wall, with coping extending considerably beyond the neat shaft. This extension, of course, was for the purpose of reducing the size of caisson as much as possible.

In spite of its apparently light construction, this caisson was handled very satisfactorily. It was subjected to very considerable strains because the bedrock was considerably deeper on one side than on the other and the caisson had to be supported while the higher side was blasted down. The vertical timbers at each corner of the octagon extended from the cutting edge clear up through the roof, and the side timbers were bolted to them at each intersection. This, together with the vertical sheeting, tied the caisson together very well. For the outside strains there was one belt of waling timbers around the bottom of the cutting edge supported by the radial struts in the bottom of the chamber.

Rigid economy in the use of both timber and steel was necessary in this work in order to build the bridge within the funds provided. Reinforced concrete caissons were considered but abandoned on account of additional cost and slowness of operations in construction, which might, with sudden fluctuation of the river, be the cause of flood difficulties. Wooden cylinders were, therefore, adopted for the bases. These were made of beveled staves 6 in. wide and about 2½ in. thick. They were placed flat sides together. Steel hoops were placed on the outside of the staves so as to make a large section of wooden pipe. The roof of the working chamber was made of two layers of 4-in. plank placed at right angles. The inside of the working chamber was sheeted with vertical planks 2 in. thick nailed to the staves. The edge thus provided supported the roof of the working chamber and swelling at this point was prevented by a hoop placed outside, just at the roof line.

The working shaft was designed to be a piece of stave pipe with ladder rungs and the lock was to be used on top of this wood stave pipe. It developed, however, that the contractor had a supply of steel shafting working pipe and the engineers accordingly permitted the use of a form for the concrete somewhat larger than the pipe. The steel shaft was used successively on different piers.

In order to transfer the weight from the concrete to the outer wood pipe, during sinking, various short pieces of 2 in. plank from the waste pile were nailed to the inside of the staves. These wooden pipes were built in vertical position inside of the steel hoop rings, nailed successively each to

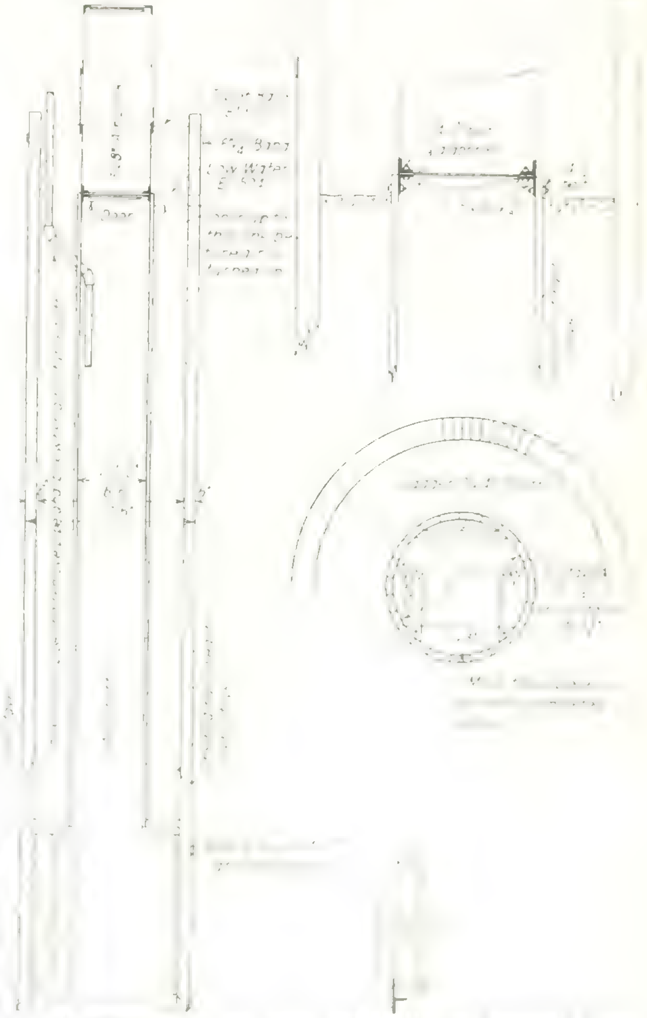

Fig. [illegible] Bridge.

[illegible] w staves were driven in wedge fashion as tightly as pos- [illegible] y tight barrel-like shell. It was, of course, a substitute [illegible] and proved to be a very satisfactory substitute.

[illegible] Red River bridge are shown in Fig. 2. When these [illegible] bedrock and the work [illegible] working shafts were [illegible] and the forms were also removed [illegible]. The cylinders at the Arkansas River bridge were 12 ft. outside diameter, but at the Red River bridge they were from 9 ft. to 11 ft. 6 in. diameter.

The same idea of the [illegible] cylinders was carried out at the Canadian River bridge, but here they were reduced to an outside diameter of 7 ft. 6 in. even though they were sunk from depths varying from 22 to 36 ft. On account of the large amount of steel required for the hoops a wire [illegible] except at the working chamber where the steel hoops were used, the entire base was wrapped [illegible] and held in place with 2-in. stables about 24 in. apart. These cylinders were so small that the use of the inside form and the removable steel shafts was not practicable, so that the original scheme of the wood stave pipe was adhered to.

At the top of the wood stave pipe there was bolted on a flange angle to which the standard steel air lock was attached. Several of these piers have been completed and no great difficulty has been encountered with them except those incident to the sinking of so deep a pier with diameter so small. It would not have been possible to proceed with the construction of this bridge if it had been necessary to use ordinary steel pneumatic cylinders throughout.

Production and Price of Portland Cement in 1918

The production of Portland cement in 1918 was the lowest since 1909 according to statistics compiled under the direction of Ernest F. Burchard, of the U. S. Geological Survey, Department of the Interior. The decrease in output was the effect of the war restrictions imposed by the Government upon fuel supplies, transportation facilities, labor, and private construction in general. The shipments of Portland cement in 1918 amounted to 70,915,508 bbls., valued at $113,153,513, compared with 90,703,474 bbls., valued at $122,775,088, in 1917, a decrease in quantity of 21.8 per cent and in value of 7.8 per cent. The production in 1918 was 71,081,663 bbls., compared with 92,814,202 bbls. in 1917, a decrease of 23.4 per cent. The stocks at the mills increased from 10,353,838 bbls. in 1917 to 10,453,950 bbls. in 1918, or 1 per cent. The decrease in shipments and in production was general; it covered every state and commercial district and ranged from 8 to 40 per cent. According to the producers' reports about 54 per cent of the capacity of the cement-manufacturing plants of the country was utilized during 1918, but the capacity operated in the several states ranged from 38 to 70 per cent. The average factory price per barrel for Portland cement in bulk in the different states in 1918 ranged from $1.511 in Pennsylvania to $1.894 in Washington; in 1917 it ranged from $1.22 in the Lehigh district to $1.69 in Washington. The average factory price per barrel for the whole country was $1.596 in 1918, compared with $1.354 in 1917, an increase of 24.2 cts., or 17.9 per cent. The prices in these two war years are the highest that have been realized for Portland cement since 1898 and 1899, when they were respectively $1.62 and $1.43 a barrel. The lowest average price, $0.813, was recorded in 1909 and 1912. The combined production of natural and puzzolan cements in 1918 was 432,966 barrels, valued at $401,341, compared with 639,456 bbls., valued at $435,370, in 1917, a decrease in quantity of 32.3 per cent and in value of 7.8 per cent.

24½ Per Cent of Fabricating Shop Capacity Contracted for in April.—The records of the Bridge Builders and Structural Society, as collected by its secretary, show that during the month of April, 1919, 24½ per cent of the entire capacity of the bridge and structural shops of the country was contracted for.

Draftsmen at Portland Form Union.—Draftsmen at Portland, Ore., have organized a local branch of the Draftsmen's Union, which is affiliated with other unions along the Pacific Coast and with the American Federation of Labor.

Prices During the War and the Readjustment Period*

BY T. S. HOLDEN

[illegible] of Labor

A study of the index figures of commodity prices in the United States and certain foreign countries shows that while prices have risen very considerably in this country through the war period, the rise in other countries has been greater. According to the figures of the Bureau of Labor Statistics, the wholesale prices of all commodities in September, 1918, were 107 per cent over the average for the year 1913. This was the highest figure reached in this country. The price level in Canada, according to the Canadian Labor Department, reached the high point in November—the price level then being 115 per cent over the 1913 figure. According to the figures of the London Economist, the price level in the United Kingdom was highest in the month of August, being at that time 133 per cent above the 1913 average. Figures on the increase of prices in France are not available for any time later than June, 1918; however, the index figure as published by the Statistique Generale for the month of May showed an increase of 235 per cent over the 1913 price level. Not only do the countries nearer the scene of actual warfare show greater rises in the price level, but it is also true that in these countries the prices began to rise at an earlier date than they did in the United States.

A comparison of the rise in the price level in these countries is shown graphically in Fig. 1.

Great Increase in Currency.—The general rise in commodity prices was accompanied in all these countries by a considerable increase in the amount of money in circulation and in the amount of bank deposits. In this country the average amount of money in circulation per capita in the year 1913 was $34.65. This increased to $56.23, the figure for Dec. 1, 1918, an increase of 62 per cent. There has been a slight decrease since that time, the figure for March 1 being $53.76, which is 55 per cent above the 1913 figure. During the same time bank deposits in the United States have increased almost threefold. In European countries during the war period bank deposits more than doubled.

Prof. Irving Fisher, of Yale University, published about a month ago a monograph entitled "The New Price Revolution," in which the facts concerning the increase of the amount of money and of credits were brought out, and the statement was put forward that this increase was responsible for the general rise in the price level. Prof. Fisher also pointed out that it is extremely unlikely that there will be a decrease of money and credits in either this country or European countries within the next few years, and that the price level will remain permanently high as compared with the prewar level.

Prices During and After the Civil War.—A comparison of the course of prices during the Civil War and the present war shows many points of similarity during the two war periods. The course of prices during the present period of readjustment and the corresponding period following the Civil War shows more points of difference than of similarity.

During both wars the wholesale prices of commodities in general rose steadily through the war period. The rise during the Civil War period, taking the year 1860 as the base, runs up to a somewhat higher level than the rise during the present war. In both wars building materials rose in price, but they did not at either time reach levels as high as the price levels of other commodities.

At the beginning of the year 1865, the end of the Civil War being in sight, wholesale prices broke suddenly and violently. During the first six months of the year prices in general fell off 27 per cent from the high level of January. However, the break in wholesale prices, though unprecedented in violence and accompanied by the unsettling influence of the end of the great war, produced no business crisis or depression. Through the latter half of 1865 prices recovered from the low point until in January, 1866, they stood just 16 per cent below the level of January, 1865. From the beginning of 1866 prices dropped slowly downward. They did not reach the prewar level until the year 1878. As is well known, during that period of inflated currency gold was at a premium. However, commodity prices remained [illegible] the prices of gold up to and including the year [illegible]

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*Abstract of a paper presented, April [illegible], 1919, [illegible] New York Chapter of the American Institute of Architects.

Building materials declined in price along with other commodities during the first half of the year 1865. However, the fall was less than in the case of other commodities. Whereas commodities in general dropped 27 per cent, building materials dropped only 14½ per cent. The recovery during the second half of the year was more marked, prices of building materials returning to the level of the last quarter of the year 1864, and remaining at that level for a period of a year before the decline set in. The index figure for the building materials group remained higher than that for all commodities up to and including the year 1874.

The currency was on a distinctly unsound basis in the Civil War reconstruction period. The sharp fluctuations in prices gave rise to much speculation and the opportunities for development of the resources of the country, such as unused land, rivers and harbors, building of railroads, led to overexpansion of business, resulting in the financial panic of 1873. This panic was not accompanied by any sharp decline in prices.

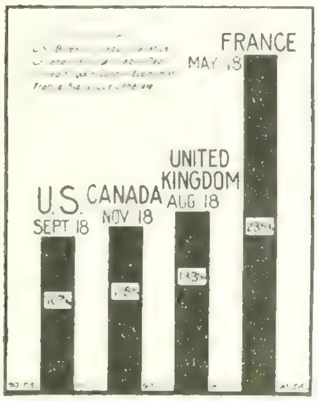

Fig. 1—Maximum Rise of Price Level in United States and Other Countries.

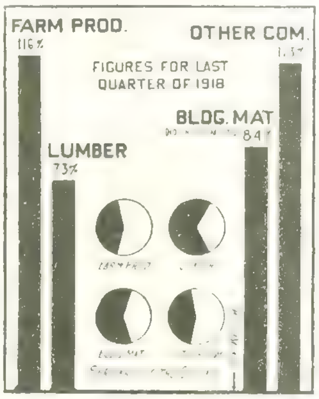

Fig. 2 Comparison of Rise in Building Materials and Other Commodities.

As was stated above it was [illegible] years after the Civil War before prices returned to the pre-war level. The principal cause of the return to the pre-war level was the fact that there was such abundant opportunity for the development of new and more economic methods of production in the shape of new forms of machinery and new kinds of business organizations. These opportunities we do not have at the present-day in any measure comparable with the previous period.

Price Index.—Through the period from Oct. 1, 1918, to the present time commodity prices have been going through an orderly process of readjustment. Although there have been many declining prices, at the same time there have been others advancing. On March 1 Dun's index figure (the average wholesale price of 313 commodities) showed a decline of 6.9 per cent from the high point of Oct. 1. During the month of March, in spite of the considerable declines in steel, there were sufficient advances in other commodities, mainly foodstuffs, to cause a slight advance in the price level. The index for April 1 shows the price level only 5.7 per cent below the high point of Oct. 1.

The London Economist's index figures show that from Sept. 1, 1918 (the highest level reached), to March 1, 1919, the price level fell 7.5 per cent.

Of 313 commodities quoted in Dun's Review of March 8, 1919, 140 were quoted at prices lower than they were a year previous, and 126 were quoted higher than they were the year previous. The index figures indicate a reduction in the price level from March 1, 1918, to March 1, 1919, of 4.8 per cent. The commodities which were quoted at prices lower than last year's prices consisted of certain foodstuffs, drugs and chemicals, wool, woolen and cotton textiles, metals, and oils. With the exception of steel products, no building materials were quoted at prices lower than last year's prices. Of the commodities which were higher in price than they were at the same time last year, the principal ones were certain foodstuffs, lumber and other building materials, drugs and chemicals, hides, naval stores, oils, paint, and tobacco.

Copper and Lead.—Of the commodities that have been included in the study of the price level, the most marked declines since the armistice have occurred in the case of lake copper and pig lead. In November copper was 69 per cent above the pre-war price. Since that time it has dropped down to the [illegible]. [illegible] November [illegible] per cent above the pre-war price, and at the present time it is only 17 [illegible] war [illegible] are usually exported in large amounts and there has been no export demand; consequently the very considerable declines in prices [illegible].

In general, the course of prices since the armistice, as has been outlined, seems to bear out the theory that a new price level has been established.

Steel and Iron Prices.—In the case of iron and steel products war orders for the entente allies began to figure largely during the second half of the year 1915. Demands for steel production were greatly increased and prices advanced at that time. Steel prices continued to advance through the year 1916, and in 1917 it developed that a very large proportion of the steel output of the country would be needed for war uses. Prices of steel, iron, and coke soared to unprecedented levels, until the Government found it necessary to fix the prices on these commodities. The Government's fixed prices ruled the markets from the last quarter of 1917 until the end of 1918.

Most steel prices, before the Government assumed control, were over three times the pre-war figures; some were nearly six times the pre-war figure. The Price-Fixing Committee brought these prices down very considerably. However, the Government's fixed prices were still very high in comparison with pre-war figures. If the average for the period of July 1, 1913, to June 30, 1914, be taken as the pre-war base (100 per cent), an average of prices on finished steel products in force at the time of the armistice shows an index of 228. Since the maximum possible production of steel was desired, these commodities being considered as essential for war purposes, it was necessary to fix the prices at such a figure that the producer whose costs were greatest might enter the market and make a fair profit.

The steel industry announced reductions on various items early this year. These reductions brought the index figure on steel products down to 217. The declines, however, were not considered by the buying public as being sufficient to interest them. No orders resulted from these declines, and the steel interests found that further reductions would be necessary in order to stimulate buying.

Finally on March 20, after conference with the Industrial Board of the Department of Commerce, [illegible] representing the steel companies announced a new schedule of prices. The new schedule presented an all-around reduction of 14¾ per cent from November prices.

At the present time (April 9) the index figure for finished steel products is 195—that is to say, these products are now on the average 95 per cent above the figure for the period July 1, 1913, to June 30, 1914. Since [illegible] tained by a system of weighting similar to that used by the Bureau of Labor Statistics, it is comparable with the figures of that bureau. The bureau index number for wholesale prices of all commodities for the month of February was 197. It is thus seen that the action of the conference on steel prices had the effect of bringing these products down to the general level of all commodities.

At the time the new schedule on steel was announced, the steel companies stated that these prices would prevail for the rest of this year. It was also stated that the prices were the lowest possible compatible with the present wage scale.

Price of Building Materials.—There was this difference in the conditions that determined prices on steel, and on basic building materials. In the case of materials regarded as not essential, such as most of the building materials other than steel, whether the price was fixed by the Government or in the open market, this price was not sufficiently high to keep all producers in the market, simply because the maximum production was not required by the war-time needs of the country. In fact, construction itself, as well as production of various building materials, was specifically curtailed by governmental order.

[illegible] actual production of common lime in 1918 was 20 per cent [illegible] 1917. [illegible] per cent under the 1917 figure. Lumber was reduced 19 per cent in output. Common brick in 1917 was 21 per cent under 1916. It has been estimated that in 1918 the production of common brick was less than half the 1917 figure.

[illegible] commodities the markets are uncontrolled [illegible] than [illegible] in these commodities. If any one of these commodities had been considered as essential as steel the government would have been obliged to fix the prices at [illegible] at figures high enough to encourage every producer [illegible] to run his plant at maximum capacity with a [illegible] [illegible] to its output. In that case the prices on these commodities would have reached much higher levels than they actually did.

Lumber as a group during the last quarter of 1918 was 73 per cent higher in price than in the pre-war period, July 1, 1913, to June 30, 1914. The building-materials group, including lumber but not including metal products, was 84 per cent above the pre-war figure. This seems large, but as compared with 113 per cent increase on commodities other than building materials, the increase seems justifiable. The farm-products group showed an increase of 11[illegible] per cent at the same time.

It is interesting to compare the farm-products group with the lumber group. The indices show that at the beginning of the year a farmer could exchange a certain amount of his produce for [illegible] per cent more lumber than the same amount of produce would have brought him in the year preceding the war.

Figure 3 shows graphically the rise in these various classes of commodities. The circles in the center represent the shrinkage of the pre-war dollar, expressed in terms of these groups of commodities, the shaded portions representing the values of the dollar in terms of these several price levels. Roughly speaking, by the end of 1918 the pre-war dollar, as expressed in terms of farm products, has shrunk to 46 ct.; as expressed in terms of lumber, it had fallen to 58 ct.; in terms of building materials (not including steel), it fell to 54 ct.; and in terms of all commodities other than building materials, it fell to 47 ct.

A composite index for all building materials including steel, as well as lumber and the rest, would show an increase of 93 per cent over the pre-war period for the last quarter of 1918. At the present time (April 9) the index would be 189.

Building material prices increased somewhat more in the East than in the Middle West and in the West. Since the opening of the year lumber has increased somewhat in price. Common brick have also increased in the New York market. On the whole the group of basic materials, not including lumber or steel, has remained practically stationary, declines in some items being offset by advances in others. From all indications the prices of building materials on the whole do not seem to be subject to any declines of consequence in the future

Increased Cost of Building.—An attempt has been made to estimate the increase of construction costs. With the cooperation of the United States Housing Corporation, a comparison of the cost of a two-family wood-frame and stucco house, as between the present time and 1915, has been made, prices prevailing in the neighborhood of New York being used. This estimate showed an increase in cost of construction for this type of building of 48 per cent.

An architect in St. Paul, Minn., has furnished the cost per cubic yard of hospital buildings of reinforced concrete construction for each year from 1911 to 1918. These figures were based on actual buildings, all of the same type, all by the same architect and the same contractor. They show that the 1918 building cost was 80 per cent more than the 1915 building. The cost today should be appreciably less than this, with reduced prices on reinforcing material and increased efficiency of labor.

The Engineering News-Record of Feb. 20 published an estimate on a steel-frame office building in the city of Chicago, showing an increase in cost of 87 per cent over 1915. This [illegible] somewhat less as a consequence of the reduced cost of structural steel.

The subject of increased construction costs is very important, and the Division of Public Works and Construction Development is now investigating this phase of the problem with the hope of having more complete data on it in the near future.

Conclusion—A New Price Level Established.—In concluding [illegible] somewhat extended study of prices it is the opinion of the Division of Public Works and Construction Development that a new price level has been established by economic conditions attending the world war; and that economic forces appear to have already acted to stabilize prices and [illegible] are not likely to fall by any appreciable amount in the near future. It is believed that the growing confidence in the future of business in this country, evidence of which is seen on all sides, is well justified by the facts that have been learned through the study of the price situation. Evidence of the stability of business today is the fact that during a five months' period of stagnation the number of business failures has been unusually low.

At the present time there is less concern over high prices than there is with regard to the stability of prices. It appears that the wisest business men are those who decide now to go ahead with the construction of buildings and the production of goods; the need for both forms of activity is more imperative now than ever before.

How to Obtain Best Results in Glued Work

Tests made at the Forest Products Laboratory of the U. S. Forest Service at Madison, Wis., show that properly handled commercial glue develops a shearing strength greater than that of most woods.

To get full strength from any glue, proper surface contact is imperative. Good glue will adhere fairly well even with poor surface contact. Joints of this kind possess, however, inherent weakness and the added disadvantage that they are more liable to ruin through bacterial action than tight joints, since the glue in them is more exposed.

The proper application of pressure is important in all glued work, but doubly so in the manufacture of plywood. Securing proper pressure involves keeping cauls and press in first-class condition and using them skillfully. With the hydraulic press it is easy for careless or ignorant workmen to spoil a batch of stock by applying too much pressure and starving the joint.

Plywood failure may often be traced to unevenly surfaced cores. Planer work should be watched carefully and calipered frequently. A low spot in a batch of cores will mean that insufficient pressure will be obtained in that place and loose plywood or blisters may result.

Taking chances in storing and shipping glued products causes many failures. Work is frequently improperly dried and is then expected to hold together in damp rooms. Glue attains its full strength only when it is thoroughly dried. This necessitates removing the moisture absorbed from the glue by the wood. Glued work should be placed where there is a chance for good air circulation. After drying, average shop conditions should not cause failure.

Resolution for National Department of Public Works.—The following resolution was adopted by the engineering and related organizations representing a membership of over 100,000, in conference at Chicago last month:

This conference of the delegates from engineering and related organizations respectfully recommended to the public and to the Congress, that legislation be enacted covering the following principles:

1. That the service and bureaus of the National Government having to do chiefly with matters of engineering and architecture, be grouped in one department to be known as the Department of Public Works.

2. That the Department of Public Works comprise those works which are built and operated for the use of the public.

3. That the Department of Public Works be made available when desirable for the performance of special engineering and architectural work for the use of other Government bureaus.

Breaking Ice Gorges at Bridges with Pile Driver Hammer.—In a letter to [illegible] Railway Maintenance Engineer, Mr. B. F. Gehr, Master Carpenter, Pennsylvania Lines, states that ice jams at bridges can be economically broken up with a pile-driver hammer. The hammer is securely fastened to the lead line of a derrick mounted on a car such as is commonly used to handle bridge timbers, steel rails, and other heavy maintenance material. The derrick should have a boom about 40 ft. long, so as to reach some distance out from the bridge. When handled by a work train it can be moved to any point on the bridge and the hammer allowed to drop onto the ice, breaking it up so that it will pass under the structure. The expense is small, as two men, and the foreman in addition to the crew of the work train will break up almost any gorge.

Practical Considerations in Design of Steel Mill Buildings

The design of steel mill buildings may be considered [illegible] two ways, first, in what may be called the theoretical design and second, the practical design. A theoretical design is one in which the calculation of stresses and the proportioning of members according to mathematical rules are the dominant, if not exclusive, factors. A practical design introduces many features learned only by experience. The one is not necessarily contrary to the other. It is usually taken for granted that a building designed by a mere theorist will be unsatisfactory, but many a building designed by a so-called "practical" man has given trouble. Crane girders have had to be strengthened against lateral vibration, jib cranes have failed, trusses have unduly deflected, bracing has been inefficient, all because the "designer" had insufficient theoretical knowledge of the theory stresses. In a paper presented before the Buffalo Engineering Society, Mr. R. Fleming of the American Bridge Co. points out some of the practical considerations that enter into the design of these structures. An abstract of his paper follows:

Proposed Uses of Industrial Building Determine Its Design.—The design of a proposed industrial building should be determined by the uses to which it is to be put. Preliminary data should be obtained. Studies should be made of other buildings in which similar work is being done. Industrial processes should be understood and proper provision made for carrying them on efficiently and economically. Too much stress can not be laid upon these points. Many a building has been handicapped for all time by too many interior columns. Especially is this true of steel mills. The additional first cost of a long truss or girder would have been paid for 2 or 3 times a year had no column interfered with handling material about a forge or press. In one machine shop a light traveling crane would often be a labor saving device but it can not be installed because of insufficient head room. In another building an excessive vibration is found. All of these conditions may have come because the designer did not sufficiently understand the industrial processes to be carried on in his building.

Another necessity, or rather a wonderful convenience, in a building is adaptability for extension. The cost of making full trusses at the ends is but trifling compared to the convenience they will be if the building should ever be made longer. Industrial processes are constantly changing. Heavier machines are being used. Even if a gallery floor of a machine shop is strong enough for present needs, will it be for the needs of 5 years hence? If a business succeeds at all it will grow. A lack of vision or a false idea of economy at the start has often been atoned for later at great cost in making alterations or in loss of business.

If the building is to be used for manufacturing purposes, a lay-out of the machinery should be obtained from the mechanical engineer. This is necessary to locate columns to the best advantage. In these days of specialization we have also the heating and ventilating engineer, the illuminating engineer, the sanitary engineer, and others. When the steel work is but a comparatively minor part of the structure the work of the architect precedes that of the structural engineer. Where the steel work predominates, the structural engineer should take the lead. In the design of mill buildings he is often both engineer and architect.

A proposed building may be within the limits of a city having a code of building laws. Unfortunately, few building codes are written with the steel mill building in mind. As far as steel requirements are concerned the place of public assembly and the many-storied building are chiefly in evidence. The result is that the designer of a steel mill building is obliged to grope his way through requirements for other kinds of structures or take chances and cut away from the municipal code altogether.

Lighting.—In late years the question of proper lighting and its economic value has been widely discussed. In an average 24-hour day we have 11¾ hours of darkness, 4½ hours of cloudy or foggy atmosphere and 7¾ hours of sunshine. Hence manufacturing plants must operate for part of the time by artificial light. We now have the illuminating engineer to deal with this feature but it belongs to the structural engineer to make the most of the natural or day light. This is a problem of the quality of light admitted as well as the quantity, a problem of distribution as well as extent of sash area. [illegible] building has been glazed. But too much light may create a glare and be as harmful as too little. In a 1-story building in Pennsylvania the workmen are obliged at times to wear sunshades. The windows or sash should be low if there are benches along the wall or if light should be needed near the sides. To light the central portion of the building they should be as high as possible or directly under the eave strut. A combination that has given excellent satisfaction is a belt of continuous sash directly under the eave extending all round the building and the balance of side and end area filled with belts of brick, tile, concrete or sheet metal and continuous sash. Or, windows of large size can be set in the side covering. Skylights in the roof are expensive, are liable to breakage, are a frequent cause of leaks and when covered with snow do not admit light.

[illegible] proportion [illegible] roof areas of a building no definite rules can be given. In general it may be stated that the proportion in the sides should be large—say 50 or 60 per cent, and in the roof small—not over 10 per cent. For wide areas what is known as saw-tooth construction is being extensively used. It is a series of trusses with one side vertical or slightly inclined and glazed, and the other side covered with roofing. The glazed side should face the north. A diffused light thus illuminates the floor below without casting shadows. Other forms of construction have given excellent satisfaction.

Ventilation.—[illegible] whole row of sash may be "top hung." Windows opening in the usual way are often used, or the sash may be balanced, saving the expense of counterweights. A monitor is often built on the ridge of the roof with sides of sheet metal, swinging shutters or fixed louvres. With the sides of swinging or sliding sash both ventilation and light are secured. Tubular ventilators of which several makes are on the market, placed at intervals along the ridge of a roof are effective in creating an upward current of outgoing air. About 1 sq. ft. of ventilator area to from 200 to 400 sq. ft. of floor area should be [illegible]

Heating.—A common system of heating is that of forcing fresh air over heated pipes in a cast iron case and from thence distributing through conductors into various parts of the building. Other systems of heating are in use, but it is seldom that questions of heating are decided by the structural engineer.

Plans and Specifications.—"To be strictly executed in accordance with the plans and specifications," reads almost every building contract. The plans should embody the design of the building. If drawings are only wanted to give the prospective purchaser an idea of his building, a great deal of information can be omitted that is necessary on the finished design. It is a wise plan, however, to make even the preliminary drawings as full and complete as time and circumstances will permit. Clearness and accuracy should be essential features of the plans. Three engineering rules often neglected are: Make provision for special loadings. Be sure that the building is well braced. Carry all wind stresses to the ground. The neglect of these rules has proved disastrous to many structures.

The specifications should be clear, accurate, concise, consistent, complete and fair. Explanations of their meaning should not be necessary. They should not be so long as to be unwieldy nor should anything essential be omitted. Great care should be taken that the scope of the work to be furnished is clearly defined. It should be definitely stated whether stacks, tanks, elevator framing, stairs and similar items are included or excluded. Any special features should be emphasized. "Blanket" clauses and those embodying unusual requirements should be avoided.

In the examination of more than a thousand specifications for structural steel buildings some were found to be so very general in their provisions that they lacked definiteness, others entered into detail to such an extent as to embarrass the contractor. In some the writers had depended upon others and did not use good judgment in copying. Some were ambiguous, and others were unfair. A specification is unfair whenever it throws the burden belonging to one party upon some other party. Almost invariably the steel contractor is the one who is called upon to shoulder what does not belong to him.

The Commercial Features of Structural Engineering.—Both designer and purchaser should know that there are commercial features in the design of steel structures which should not be ignored. For instance a design may call for sections that are seldom rolled. This means delay in delivery from the rollers and may result in the whole structure being held up indefinitely for one or two special sections. The fewer the sizes used, the more duplication there is in working drawings and in fabrication. Again, the designer should consider the ease with which rivets can be driven. A column made of two channels with toes turned in and laced is a hard column to rivet. Questions of transportation and erection should be given attention. By shipping trusses "knocked down" more weight can be loaded on a car, thus lessening freight but requiring that more assembling and riveting be done in the field. If shipped in large sections the cost of transportation and handling may be greater but that of erection will probably be cheaper. Care should be taken that the length or weight of pieces do not exceed the capacity of the erection equipment and that field connections can be easily made. These and similar questions must not be ignored.

Lastly, it is difficult to unduly emphasize the importance of good detailing. Close fits are expensive. Eccentric rivet connections producing secondary stresses should be avoided as far as possible. In fact poor details can mar an excellent design.

Breaking Up Concrete With Dynamite

Concrete structures, either plain or reinforced, are considered of the most permanent nature. It is, however, often necessary to remove or destroy such structures. It may be an old concrete wall, bridge abutment or pier, a foundation under a building, the lining of a tunnel or an engine bed. Many times these objects are inside factory buildings and adjacent to valuable machinery, or the mass to be removed may be in close proximity to buildings, or to a city street congested with traffic or under an office building.

The customary method of removing old concrete so situated is by drilling holes with jumper steel and sledges by hand and then breaking off the material bit by bit with wedges. This is a very slow and expensive way to handle work of this kind. Another method of removing old concrete, brick or masonry, is by blasting with explosives. In doing this class of work care must be exercised to see that the holes are properly located, and that light charges of explosives are used. It requires no particular caution or ability to blast old walls of concrete, brick, etc., that are located in open places, where there is little likelihood of damage to surrounding property. But it is in cases where the structures to be removed are located close to and often are a part of valuable property, machinery and buildings, that care and a nice sense of judgment must be exercised, and it is for such work that these instructions are written.

An explosive of relatively slow heaving action, like ammonia 30 per cent to 40 per cent strength, is best adapted for such work rather than a very quick and shattering explosive.

The drilling of holes is best accomplished by the use of self-rotating hammer drills, but when the size of the work does not warrant such equipment, holes can be drilled by hand, using jumper steel or hand drills and sledge. It is best to demolish the structure by gradual steps or benches, or a little at a time, especially is located inside or under a building. Holes are drilled, as a rule, from 1 in. to 1½ in. in diameter, and in depth depending on the thickness of the material, although 6-ft. holes are about as deep as should be shot in close quarters.

One of the concrete abutments under a bridge had become undermined and had fallen into the channel of the stream. The concrete block was straight for the width of the bridge and had wings at each end intended to brace and anchor it into the earth. The block was about 3 ft. thick and 7 ft. wide, and was covered with about 18 in. of water. The wings were sticking up out of the water and obstructed the channel. Ammonia 40 per cent dynamite was used. The shot broke off the two wings and broke the center section in two parts. The blocks left by the blast were small enough to be handled by laborers, and were used as the foundation for the new abutment, built shortly afterwards. The entire job took just one hour.

The Lighting of Buildings*

The equipment of a modern building, adapted for the intensive indoor life of these times, is so complicated that its design presents what is frequently a difficult engineering problem, involving so many functions that a number of highly technical professions and trades have grown up around them. Indeed, many of these branches of construction have become so important that on them largely depends the successful and economical operation of well-nigh every building.

Building Comfort.—Life in such buildings hinges about their mechanical and electrical equipment, without which they would be quite impossible. Thus, in large, densely populated structures, the traffic problem becomes a subject for calculation quite as much as planning. Elevator equipments can no longer be proportioned by purely empirical rules. They should be designed directly in relation to the number of people that must be handled in a given time. Otherwise an insufficient or unnecessary expensive installation may result. An insufficient elevator equipment throttles the traffic and reduces the usefulness of the building.

In large buildings, the design of the heating and sanitary equipment become problems of such magnitude that errors may be very costly. A very slight lowering in efficiency may involve considerable annual operating costs.

But none of these equipments involve the personal comfort of the building occupants quite so directly as illumination. We may growl a bit if delayed in getting to our offices or work, and wear coats if chilly, but these things are of passing moment when not totally impossible. On the other hand, if we cannot see to work, if our offices are dark or badly lighted, the effects are much more marked because continuous, and our efficiency, often unconsciously, is markedly impaired.

We cannot leave this question of lowered efficiency due to poor lighting without drawing attention to the reports of several conclusive tests (W. A. Durgin, "Productive Intensities," Transactions Illuminating Engineering Society, Vol. XIII, No. 8), showing that in industrial plants increases in production as high as 50 per cent resulted from substituting well-designed lighting equipments for existing equipments of poor design. Further tests of the efficiency of the eye used in such ways as would be entailed in general office work (Feree and Rand, "Tests on the Efficiency of the Eye," Transactions Illuminating Engineering Society, Vol. VIII, p. 40; Vol. X, p. 407), have shown very marked differences in seemingly insignificant variations in the character of the ilumination—variations that are no greater than may be found every day between one modern building and another—yet such differences in eye efficiency produce a marked and measurable falling off in the amount of work accomplished in a given time. It has also been shown that such lowering in efficiency, if maintained over long periods, results in a permanent reduction of the whole human organism's ability to respond to the will. It would be well for those whose interest is sufficiently alive to read in this connection a little pamphlet published by the Illuminating Engineering Society called "Light—Its Use and Misuse."

The Illuminating Engineer.—Due to the comparatively recent development of high-efficiency lamps, both gas and electric, the latest addition to the array of talent involved in the successful design of a modern building is the illuminating engineer. The illuminating engineer is young and, filled with the enthusiasm of youth, he has sought to "put over" his ideas without much consideration of the architect's bigger problem, which is indeed, a complex manifold.

The illuminating engineer has had little patience with the architects' and the lighting fixture makers' adherence to standards and devices based upon conceptions tracing back to the "dark" ages. He knows and can prove that his fundamental principles are correct, but has lacked the ability to state his case clearly and convincingly. He has rarely been able to show the architect that his results are esthetically possible. Steeped in a new application of science, he has failed to see that his true aim is not to force the use of devices conceived in the laboratory, but to put into practice the principles of good lighting, whether these principles be applied to the design of a purely utilitarian device or a most decorative chandelier. As we shall see later, these principles are quite simple and, with a little common sense and [illegible] taste, can be applied to any interior however elementary or rich in treatment.

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*A lecture prepared by the "Committee on Lectures to Architectural Students" of the Illuminating Engineering Society, 29 West 39th Street, New York City.

The one thing that the illuminating engineer is justified in demanding of the architect and the fixture manufacturer is that both shall realize that moderin illuminants, if not properly used, possess immense power to do bodily harm through eye-strain, and that lighting devices, whether simple or decorative, must be designed with this in mind. It is not possible to use the modern incandescent lamp safely without ample eye-protection.

The architect and fixture-maker cannot logically claim that the modern illuminant, which has come to stay, cannot be incorporated in their designs without destroying their value. It is their problem to conceive adaptable designs, as it was the problem of their artistic forefathers to produce designs built about the candle and kerosene flame. The difficulties involved should only make the problem the more interesting.

The great masters of art frequently, if not always, have been scientific students of their media. Some of them have shone as scientists. Indeed, the scientific method had its roots in the attitude of mind that also brought forth the arts of Hellene. To achieve perfection, the artist must thoroughly understand the character and strucure of his vehicle of expression. But art, like science, fails in its appeal unless it is practical. Pure science, like pure art that does not lend itself to everyday use, and that does not add something to the ease and comfort of living, never achieves its final purpose.

We are accustomed to saying "This is a practical age." But is it relatively more practical than any other age? Was not Rheims Cathedral, looked at from the viewpoint of its time, as eminently practical a structure as a modern reinforced concrete factory building? Perhaps more so because the modern architect has quite generally failed to base his practice on living, practical things.

The difficulty is that modern graphic art has become a sort of Taotism—a cult trained to look backward to ancestral conditions and not forward to the ultimate culmination of modern life.

This is, at least, the viewpoint of the illuminating engineer who finds himself in sympathy with the architect's problem. His ambition is to aid in the beautifying of buildings through application of the practical possibilities of modern lighting.

Seeing.—Since most arguments begin because of the lack of a common definition, we shall start by determining what we mean by seeing. When we see anything, we are conscious of a pattern of visual sensations. Since the only two visual sensations are those of brightness and color, we shall say that what we see is a pattern of colors varying in brightness. And to clear up any misunderstanding, let us say that black, white, and all intermediate tones of gray are colors. In this sense the blackness of a totally dark room is a color of zero brightness, for at times it certainly is a very vivid sensation.

A blind man has no visual sensation whatever—not even blackness.

Color Sensations.—These sensations are aroused by certain physiological processes stimulated in the constituents of the eye retina when light falls upon it. These processes have been divided into that arousing the sensation of brightness and three color sensations corresponding in their purity to the sensations aroused by three definite hues of red, green, and blue. All visual sensations of color appear to result from the varying degree to which these three processes are stimulated. The red and green processes stimulated alone and to equal degree produce the sensation of yellow. "Yellow" light stimulates both these processes. The three processes acting together produce the sensation of white. All colors tend to go white with increasing brightness. The various forms of color blindness result from a failure of one or more of these processes to function.

The Eye Function.—The retina is protected and the amount of light admitted to the eye controlled by muscular action on the iris, causing it to increase its aperture with decreasing light and decrease its aperture with increasing light. This control is stimulated by the intensity to which the retina is lighted. If one part of the retina is brightly lighted and another part dark, both parts seek to control the iris in opposite ways, giving rise to one form of eye-strain. To prevent such strain, the contrast between the brightness of different parts of the field of vision must be kept within proper limits.

If the retina is constantly lighted to a fixed intensity, the iris muscles become tense and another form of strain results. To avoid this, the field of vision must vary in brightness from time to time so as to keep the iris muscles active.

The iris processes above mentioned are aroused by radiant energy in the visible range (generally called "light") falling upon it through the iris aperture. The light received from various parts of the field of vision is focussed on the retina by the lens so as to produce on the retina a pattern of [illegible] and color corresponding to the amount and color of the light radiated or reflected from the various parts of the object seen.

Light the Primary Medium.—[illegible] planation is to bring out the fact that the primary medium in which the architect works is light. He produces patterns in brightness and color by means of light reflected from his construction and their decorations. These patterns, translated into visual sensations, are what we see. It follows, then, that unless the object receives just the right character distribution and color of light, it cannot produce the right pattern, and the message it conveys is more or less distorted. There is no such thing as beauty in an unheard symphony or in an unseen painting.

A design in perspective and color may indicate just the idea the architect has in mind. But when it is built and lighted by the means at hand, will it look the same? Will the delicate tints maintain their hue? Or will they lose their character with a change in the color of the light? There is little blue in the light emitted by the highest efficiency modern illuminant.

It is easy to draw a mold of graceful contour, but when it is in place will the pattern of high lights and shades produce the same visual impression? Then, we do not see its contour. And if it be drawn in relief with shadows à la McGoodwin, will the same shadows be produced when it receives light only from a window or a low-hanging chandelier? Can this chandelier, pretty in itself, light the room so that it will look as the architect conceived it in his mind's eye?

Thus does light and illumination control the final result. And, lest it be thought we are drawing distinctions rather finely, let us remember that it is just such refinements that cause us to admire so greatly the works of the masters. Yet we copy their cathedrals, sublime in their dim distances and deep shadows, and fill them with glaring brightness.

The second object of our description of the function of the eye is to show that the solution of the general problem of illumination depends upon knowing what we see, how we see, and why we see. The answers to the "what," "how," "why" must be given in terms of psychology, physiology, and physics respectively. The subjects are of relative importance in establishing the principles of good lighting almost in the order given. Any proper method of lighting, artistic or utilitarian, must fill the conditions so set.

The Psychology of Lighting. Outside of the physical structure of the brain there is probably no other organ, except the eye, so capable of wide adjustments through the influence of use, environment, and training. In a comparatively short time the eye can be trained to be exceedingly sensitive to brightness or color differences. Development of one sense usually decreases the sensitiveness of the others. Sometimes this super-sensitiveness is the result, not of training, but of environment. Habits of seeing are thus quickly developed. A man accustomed to living immersed in one kind of lighting feels decidedly uncomfortable in another, even if, physiologically, the change is a wise one.

Prejudice Against Generalized Lighting. Factory hands and clerical forces accustomed to working with individual localized lighting almost invariably object if the lighting be changed to general illumination of relatively high intensity, which change, experience and test have shown, decidedly increases eye-comfort as well as production. (See "Code of Factory Lighting" published by the Illuminating Engineering Society. This Code has been incorporated in the factory laws of many states.) The phenomenon is purely psychological and is so important that at least one firm of engineers makes it a practice to lecture to the hands or clerks on the subject of [illegible]

[illegible] the clerical forces of a large insurance company. The localized lights were removed and generalized lighting installed. [illegible] in the clerks' presence. Their interest was aroused and several changes made, the last change being to reinstall the objectionable condemned system without the clerks' knowledge. All hands at once agreed that the improvement was marked. Since that time no further difficulties were encountered, and, so far as is known, the occupants are not aware that the illumination in use is identical with the system which projected the trouble.

Numerous similar cases might be cited. One, for instance, of two officers in a bank, both occupying similar desks, in similar locations, similarly lighted. Both objected to the lighting for diametrically opposite reasons.

One office manager declares that his clerks complain of the lighting and want another system installed, while in another similar office the clerks object to the lighting wanted in the first case and want the lighting to which objection is raised by the other office. Tests show that both systems are practically equivalent as to eye-comfort and efficiency.

A commonly satisfactory method is to install the proper lighting equipment in one smaller office, where the conditions may be controlled without objection, and leave the system to create its own demand, which, experience shows, is almost certain to arise. Of course, this method is only practical where existing equipment is to be modified.

The Effect of Eye-strain.—Another matter that should be touched upon here is the very important one of bodily comfort. The optic nerve centers are very closely associated in the brain with those of the stomach. Trouble in one region almost invariably engenders trouble in the other. Cases are on record where stomach disorders have been brought on by continued eye-strain, and nothing so quickly upsets the whole organism. This has become so common a matter that doctors frequently diagnose the cause of stomach trouble as due to defective lighting. Children are particularly sensitive in this way, so that the natural and artificial lighting of schools and other places where children congregate should receive particular attention. (See "Code of School Lighting" published by the Illuminating Engineering Society.)

Light thus has a very peculiar psychological effect, particularly as to color and distribution. Color in light may be used to arouse emotional moods quite as readily as music. All modern stage-lighting is founded on this fact. Attempts have even been made to combine color in light with music so as sharpen the emotion. Such attempts, while founded on a correct principle, have failed because color has generally been treated as an additional voice in the orchestra. (See "Mobile Color and Stage Lighting" by Bassett Jones, Electrical World, Vol. 66, No. 5, July 31, 1915.) Witness as an example of the effect of color and quality in light the appeal made by the sort of lighting done in certain restaurants. Some are cool and quieting, others are exciting, and still others almost sensual. A gathering of otherwise normal people can be profoundly stirred by a properly executed series of changes in the color of the lighting.

So, in the lighting of offies and other work-places, the result may be either restful or restless, depending entirely on how it is accomplished—and this entirely apart from any question of eye-comfort.

The Normal and the Abnormal.—The quality and color of well-distributed daylight is normal. Any departure from this standard is abnormal—usually depressing if toward blue and stimulating if toward red. Remember that the light from the best modern incandescent illuminants is quite red compared to day light, and this effect is sharpened by any red or buff component in the wall and ceiling treatment.

All such results as we have been discussing are, of course, modified by the intensity and distribution of the light and by the environment. A well-shaded, almost red, kerosene flame in an otherwise dimly lighted library may produce a sense of extreme comfort.

The subject is entirely too complicated to more than mention here, but at the same time it is one of the most important and the least understood in the whole art of illumination.

The problem of introducing new ideas in lighting, however correct they are known to be, is not easy. The difficulties are not amenable to calculation but must be overcome by educational methods. Habits must be corrected and new ones developed. Thus the first, and generally the most difficult, problems that face the illuminating engineer are psychological. He has to teach people to see correctly.

The Physiology of Lighting.—Above, while discussing the function of the eye, we mentioned the one fundamental phenomenon that lies at the basis of all good lighting—brightness contrast. Dr. H. E. Ives has said ("The Measurement of Brightness and Its Significance," Transactions Illuminating Engineering Society, Vol. IX, No. 3) that the art of good lighting is the art of the proper distribution of brightness. This statement should be the slogan of every illuminating engineer and of all others who do lighting. It means that if the distribution of brightness over the pattern on the retina does not disturb its normal functioning, then, so far as the eye is concerned, the object seen is properly lighted. If eye-strain is the result of the brightness distribution, then no matter how beautiful the object may be, we tire of looking at it, and in so far its beauty is destroyed.

Brightness Contrasts.—An illustration of what is meant by brightness contrast is that of a lighted candle in a dark room. The contrast of the bright candle flame against the black background is so great that the eye cannot protect itself and is blinded, resulting in serious eye-strain if too long maintained. On the other hand, the most powerful bare incandescent lamp in a white room is not immediately annoying, although eye-strain may eventually result from the excessive quantity of light received on the retina.

These are the extremes. The safe contrast is contained within a comparatively narrow range. Probably it should not exceed 100 to 1 if the eye efficiency is to be maintained at a reasonable level. (See Ferree and Rand, "Tests on the Efficiency of the Eye.")

A more practical illustration is that of a room finished in dark wood and lighted by wall-brackets and a chandelier, both bearing imitation candles capped by round-bulb frosted lamps. The contrast in this room was about 1,000 to 1 and was very trying. Since the eye was blinded, the design could not be seen, and so the architect had defeated his own purpose. The windows did not improve matters because, with a bright sky visible, the contrast was still high—over 1,500 to 1, or fifteen times the safe limit.

A practical solution of the artificial lighting of this room would be to substitute softly toned plaster for several of the wood panels and mount in the bottom of these panels the same wall-brackets now used. Substitute standard clear lamps for the frosted lamps and mount in front of the lamps a batik shade with translucent colored ornament, if desired. Let the back of the shades be white so that they will reflect light to the plaster panel, which will diffuse it into the room. The brightness contrast, while high, would then be bearable. The chandelier would be unnecessary save as an ornament, and why not let it be frankly an ornament and not a lighting fixture?

In one of the most beautiful interiors in America, the artificial lighting, which, due to insufficient daylighting, is used at all times, is accomplished by very fine examples of the metal workers' art, studded with bare frosted lamps. The lamps, seen against the generally dark-toned ceiling and walls, so blind the eye of the beholder that the fixture bodies themselves become mere dark masses and the very fine ceiling above can hardly be discerned, much less can its detail or color be appreciated. It may be added as a fact, that the number and size of lamps on these fixtures were selected, not with any relation to the illumination, but solely because that number of bulbs of a certain diameter looked best on the drawing. That, when bought, the bulbs necessarily contained 40-watt filaments was never considered as material, although 5-watt lamps in that number would have generated enough light. Actually, the 5-watt lamps, being practically as bright as the 40-watt lamps, would not have reduced the brightness contrast, but the employes would not have been drowned in light. The result is, of course, that no more than about one-third of the lamps are ever lighted.

Endless similar cases can be cited ad libitum. In fact, it is rare to find an architectural interior where seemingly any attention has been given to the all important question of brightness contrast, either in arrangements for day-lighting or artificial lighting. Both cases are equally important, and particularly so to the architect, because, when excessive brightness contrast exists, the design cannot be seen.

An interesting deduction from the principle of brightness contrast is that dark-finished rooms must be dimly lighted while light-finished rooms may be brightly lighted. It follows that dark finishes should not be used in rooms where much light is required. An additional argument in favor of this rule, that will probably more directly appeal to the architect, is that the deeper color tones used in a dark-finished room will not stand even a moderately intense light. If [illegible] lighted they fade out and lose their richness. Light on any color is equivalent to mixing gray with the pigment.

Sky Brightness.—The sky-dome, which is the source of daylight, at high noon has a luminosity that, when seen through a window from a fairly light-toned interior, will produce brightness contrasts exceeding 1,000 to 1, and more if the interior be dark in tone. Furthermore, the window is rarely out of the field of vision and generally throws its light horizontally into the room, so that none of the protecting features of the eye, which is arranged for maximum brightness overhead, can function properly. (See Luckiesh. "A Study of Natural and Artificial Light Distribution in Interiors," Transactions Illuminating Engineering Society, Vol. VII, No. 7, p. 388.) We are, however, in the habit of working under these conditions and do not realize our loss in efficiency until such conditions are corrected—as, for instance, in a studio with an overhead north skylight properly shaded, or in a room with windows arranged to transfer the light to the ceiling. The effect of the unscreened window is obvious if we try to discern the features of a man sitting with his back to it.

Daylight in the Room.—As a general thing, the daylighting of a room is at such a high level that the excessive amount of light causes the iris aperture to become very small. The surfaces or window areas are light, and if a wide sky-zone is visible from the window, the incoming light from the sky is well diffused. Such conditions cannot be easily achieved by artificial light. The areas emitting the light are small and generally at high intensity. The total amount of light is quite small, so that the effect of light quantity is to leave the iris open. Under such conditions, the retina becomes much more subject to the effect of sudden excess of light. That is to say, the iris being open, should an excessively bright object come within the field of vision, the iris has not time to close before some eye-strain has been produced. The eye-strain produced in this way by excessive light quantity is quite different from the eye-strain produced by excessive brightness contrast against which the eye has little or no protection.

It thus comes about that the level of intensities required in artificial lighting must be considerably lower than those generally met with in daylighting. The contrast between the conditions of natural and artificial lighting are most evident at the time we change over from one to the other during continuous work. The result of this change is as continuous as the work done under it, and almost always results in a marked falling off in efficiency.

It is claimed, however, that if the amount of daylight is reduced to the amount satisfactory in artificial lighting, and the brightness contrasts reduced by proper window shading, the efficiency of the eye is increased. (See Woodruff, "Medical Ethnology," Chapters XIV and XV.) Recent experiments in scientific window shading seem to substantiate this claim. Woodruff states that we are better off with less daylight.

It is probable that a high level of eye efficiency can be reached both by system of natural and artificial lighting which generally throw most of the light to the ceiling. The light is then reflected from the ceiling and diffused downward, thus bringing the brightest surface overhead. If, in addition, the color of the light is in both cases aproximately the same, and if there is a slight direct component added to produce normal shadows, then, with advantage, in both cases, the amount of light may be the same. If, then, the ceiling be white, the least possible amount of light will be lost by absorption, and if, in addition, the walls be treated in some quiet cool tone, the result will nearly approach natural conditions.

The Physics of Lighting. It is hardly necessary in these days of universal knowledge to explain that light, before it reaches the retina, is radiant energy—precisely the same as the radiant heat felt from an open fire and a steam radiator; the same as the radiant energy used in radio communication and in X-rays. The only difference between any of these forms is one of wave-length.

Light Rays.—The energy radiated from an incandescent lamp is mostly radiant heat, know as the infra-red rays. A very little of the energy radiated lies in the wave-lengths that have the power of exciting the retina and so give rise to visual sensations known as the visible rays. Still less lies in the range whose wave-length is too short to be luminous and are known as ultra-violet rays. The wave-lengths arousing visual sensations lie between those arousing the sensation of red, the longest, to those arousing the sensation of violet, the shortest. This range is known as the spectrum. Equal [illegible] different [illegible] wave-lengths do not arouse the same degree of brightness sensation. The maximum brightness sensation will be aroused by this energy in the yellow-green part of the spectrum, and here it is several hundred times as effective as it would be near the red end or the blue end.

We can therefore distinguish detail with a minimum of light if this light is yellowish green. The color sensation produced would be very similar to that aroused by the light from the Mercury Arc (Cooper-Hewitt Lamp), but any surface having a different color would appear black when illuminated by this light. This is because every pigment gets its color by reflecting or transmitting light of some particular dominant wave-length to the eye, and absorbs the remaining wave-lengths. If, therefore, we mix together a red, a yellow, and a blue pigment, the red absorbs nearly all of the blue and most of the green and yellow. The blue absorbs nearly all of the red and the remainder of the green and yellow, and the yellow absorbs the remainder of the blue and red. All the light is absorbed and none reflected [illegible] black.

This process is quite the reverse to the mixture of different colored lights, for then every step is toward white light, while, with pigments, every step is toward a black pigment. The primary light hues, the mixture of which produces white, are red, green, and blue, corresponding to the three retinal color processes. Red, green, and blue are therefore the true primaries and not the so-called red, yellow, and blue pigment primaries, because it is the color of the light by which the pigments are seen that determines their apparent color. Any shifting in the color of the light causes a corresponding shifting in color and change in brightness of the pigment. Thus blues, that are prominent by daylight, become dull and purplish by ordinary artificial light. (See "Text-Book of Color," Rood, and "Color in Lighting," Luckiesh.) In this connection it is easy to realize how important is color in the lighting of picture galleries.

In order that what appears hereafter may not seem Greek to the uninitiated reader, we shall pause here to define certain terms used in illuminating engineering. It will also save long-winded explanations later.

Light Measurement.—The visible portion of the energy radiated by any illuminator is rated in terms of the brightness sensation it will produce on reflection from a white matt surface having 100 per cent reflection factor. It is measured by comparing the brightness sensation so produced with the brightness sensation pproduced on a similar surface illuminated by a standard lamp. Devices for making this measurement are called photometers. Actually they measure brightness sensation, and are therefore psychological rather than physical instruments.

Light Units.—The standard lamp used in the photometer is compared with a standard source of light known as the "candle." The intensity of brightness sensation produced by this "candle" on a surface, every part of which is at one foot distance from it, is called the "foot-candle" and the amount of visible light at this intensity received on a surface one square foot in area is called a "lumen." The product of the average foot-candles, or average intensity of illumination over a given area, times the area in square feet, is the amount of luminous [illegible]

The actual brightness of any luminous object, such as a [illegible] directly the brightness sensation produced by the surface or source with that produced directly by the standard lamp [illegible] are compared without the intermediary illuminated surface used in making foot-candle measurements.

[illegible] it becomes spread out over greater and greater areas in space [illegible] candle-foot measurements will decrease with increasing distance. But, save for interference by intervening gas or sus[illegible] in candles per square inch. That is, in terms of the intensity of illumination that would be produced on a surface one foot distant if the source were one square inch in area and of a brightness all over equal to the actual source.

[illegible]

1. The Candle—arbitrary unit light-source producing arbitrary unit brightness sensation on a surface at unit distance.

[illegible] The foot-candle—[illegible] of illumination produced at [illegible].

[illegible] The lumen—[illegible] flux received on a surface [illegible] of one candle-foot.

[illegible] of a source of light [illegible] the intensity of illumination produced by a [illegible] area.

[illegible] ourselves briefly to some of the more technical problems of illuminating engineering.

Light Computation.—First, we shall outline the method of computing the amount of light necessary for the proper lighting of any interior. We shall do this because only in this way can the application of the principles of good lighting be developed, and the important factors controlling the success of the installation made evident. We shall be as brief as possible and give only an outline of the method, for it is not our purpose to write a handbook but to bring about a better understanding of the problem.

Let us assume that a certain amount of visible light has been let loose, so to speak, in a room. What happens to it? After it leaves the fixture it strikes on various surfaces where some is absorbed, or escapes, as through a window, and some is reflected. This reflected light again strikes on other surfaces and is again partly absorbed and partly reflected. These multiple partial reflections and absorptions keep up until all the light is absorbed. Due to the enormous speed at which light travels, the whole process occupies but a very short interval of time. If all the surfaces of the room reflected all the light that fell upon them, the light in the room would never decrease but would be increased continually by additional light emitted by the lamp or fixture. Therefore, in order to maintain a given quantity of light in any room, the fixtures or lamps need only emit in any given time the amount of light that in the same time will be absorbed. In other words, the number of lumens lost is the number that must be generated. If, then, we know how the light will be distributed in the room, or if we know the amount of light in lumens received on all surfaces due to all multiple reflections, then, multiplying these quantities by the absorption factors of the surfaces will give us the amount of light that must be generated.

But the total light received on any surface may be expressed in terms of foot-candles and may be measured or calculated as the case may be. So, if we multiply the average foot-candles over any surface by the area of the surface, we get the "lumens" received. Multiplying the lumens received by the average absorption factor of the surface gives us the lumens lost.

This may be made clearer by an example which should be followed, as from it some most important deductions will be made. Assume a room 20x20 ft. in plan, 10 ft. headroom, and containing four windows 3x6 ft. Assume that the desirable system of lighting will be such that the ceiling is 16 times brighter than the floor and 3 times brighter than the walls. The ceiling is finished white and shows a reflection factor of .70. That is, 70 per cent of the light received is reflected and 30 per cent absorbed. The average reflection factor of the walls is .50, of the floor .20, and of the windows, .15. The desired illumination on the floor is 6 foot-candles. Then on the floor, which has an area of 400 sq. ft., 6x400 = 2,400 lumens will be received and 380 lumens reflected. The reflected lumens amount to .95 lumens per square foot, which is equivalent to a brightness of .0066 candles per square inch. The ceiling is to be 20 times as bright. Hence, the reflected lumens must be 14 per square foot. This is 70 per cent of the incident lumens. The incident lumens are therefore 20 per square foot. The lumens absorbed on the ceiling are 2,400. Similarly, the lumens absorbed and lost by the walls and windows are aproximately 3,900. The approximate total lumens lost are 8,300.

There are, let us say, four ceiling outlets, and the fixtures to be used show an over-all efficiency of 80 per cent. Therefore, the total lumens to be generated by the lamps are 10,400, or 2,600 lumens per outlet. Referring to the lamp manufacturers' handbook, we find that a 20-watt lamp will more than fill the requirements. The next smaller sizes will not quite do the work if allowance is made for dirt accumulations. The total power consumption runs 2 watts per square foot of floor area. The percentage of the total lumens generated received on the floor is called the Utilization. In this case, it is .247 or nearly 25 per cent.

In the case assumed, the reflection factor of the floor is low about that of brown cork tile or darker shades in linoleum. Actually the floor will be partly covered by desks, generally lighter than the floor in color. On these desks there will be white papers. All such changes will increase the reflection factor of the floor to a point where the increased multiple reflections will materially increase the total light in the room, and hence the illumination on the desk-tops, which, by the way, are 30 in. nearer the ceiling than the floor. It will then be found that four 150-watt lamps will suffice. The watts per square foot are then 1.5, which is about normal for this kind of lighting.

Lighting Fixtures.—Now as to the fixtures. The type required to produce the brightness distribution established must be either indirect or semi-direct The first type throws all light initially to the ceiling. The second type throws most of the light initially to the ceiling and will consist of a more or less dense glass basin hung below the lamp. This basin also serves to hide the lamp from view, which is important, since the brightness of the lamp filament is enormous. In order that the fixture may reach the efficiency assumed, the glass basin must be wide open, a little flatter than a hemisphere in section, and not shaped in at the tap, or its full aperture in other ways restricted. This type of fixture, rather than the indirect type, will be used, as the luminous quality of the basin improves its appearance.

If the lamp filament is a little lower than the top edge of the basin, somewhat more than 50 per cent of the light-flux generated will be received initially on the basin. The mean spherical candles or mean intensity at 1 ft. distance of the light emitted by the 150-watt lamp is 163. That is, if every part of the basin is 1 ft. from the filament, its inner surface will be illuminated to an intensity of 163 foot-candles, or a brightness of 1.13 candles per square inch. No surface in view should have a brightness exceeding, as a maximum, .2 candles per square inch, and preferably less if the surrounding luminous surfaces are materially less than .2 candles per square inch in brightness, so that the basin must be of such quality that the brightness of its exposed surface will not exceed this amount. That is, the luminous surface of the basin must not exceed in brightness a surface illuminated to an intensity of 28.8 foot-candles. This, it will be noted, is just about the illumination on the ceiling, and is a proper condition if it can be reached. Actually no harm will ensue if the basin is thirty times brighter than the ceiling, thus introducing a brightness contrast of 1 to 30.

The intensity of the light emitted by the basin (28.8 foot-candles) is about one-sixth of the intensity of light (163 foot-candles) received on its inner surface, so that four-fifths of the incident light must be disposed of by reflection and absorption. Since the fixture is to have an efficiency of 80 per cent, 20 per cent of the total flux emitted by the lamp may be lost. The lamp emits 2,046 lumens. Therefore, 409 lumens may be lost in the basin.

A good, opal glass, with polished surface, will reflect about 70 per cent of the incident light. In this case, since say 65 per cent of the total lumens emitted by the lamp, or 1,227 lumens, is received on the glass, the number of lumens emitted by the basin, which is say, 7.5 sq. ft. in area (65 per cent of the total area of a sphere 1 foot in radius), is 7.5 sq. ft. times 28.8 foot-candles, or 216 lumens. And this is 216/409 or nearly 50 per cent of the lumens admitted into the glass. The glass must therefore show about 50 per cent absorption, which corresponds to a fairly heavy optical density, particularly if the glass is to be single thick so as to avoid undue weight.

However, since the basin, under these conditions and with a fairly bright ceiling above, may be smaller and correspondingly brighter, a basin of this density equivalent to a hemisphere 14 in. in diameter will answer the purpose.

At this point, recall the size and brightness of such basins frequently used, with even larger lamps, in rooms with comparatively dark ceilings—effectual causes of headache and indigestion! Think this over.

Treatment of Reflecting Surfaces.—It will be seen, from the above calculations of the number of lumens required to light the given room, how important is the question of the reflection factor of the interior surfaces. Since all but a comparatively small portion of the light emitted by lamps is initially received on the ceiling, any reduction of the reflection factor of the ceiling means a corresponding increase in the number of lumens that the lamps must emit. A change in this reflection factor from 50 per cent, which is the reflection [illegible] a light buff lead and oil, to 70 per cent which is the reflection factor of fresh white lead, means an increase in illumination on the working surface in the room of nearly 50 per cent, if the treatment of the wall-surface shows a reflection factor not less than 50 per cent. In one office, rekalsomining the ceiling, leaving the walls as they were, with a comparatively low reflection factor, increased the illumination on desks 30 per cent. It is not too much to say that the selection of the wall and ceiling coatings is more important than the selection of any particular type of reflector equipment on the lamp.

With direct illumination, that is, with reflectors open and pointing downward, and the lamps fairly close to the ceiling, then, under normal conditions, the amount of light received on the working areas from the walls and ceiling is between 30 and 40 per cent of the total received. This percentage is increased to about 85 per cent with the normal semi-indirect method of lighting, and reaches 100 per cent with indirect lighting.

Dinminution of Reflective Capacity.—It has been found that lead-and-oil coatings lose their reflection factor quite rapidly—about 15 per cent a year, independently of dirt accumulations—due entirely to chemical changes in the paint. In the case of kalsomines, and similar paints, the loss in reflection factor is about the same as with lead and oil, but due to the absorption of dirt into the porous paint. It is, therefore, a decided economy to use paints which contain no lead and little oil. It is possible to produce a paint of this type which maintains a practically constant reflection factor and which can be readily cleaned. The cleaning will restore the reflection factor almost to its initial value

Tinting.—Where tinting is considered necessary, it should be remembered that lamp-black has an exceedingly low reflection factor, so that even a small portion of it mixed into the paint will reduce the reflection factor of the paint materially. If tinting is essential, it should be obtained in other ways than by the use of lamp-black. For instance, a series of greys can be obtained by mixing various red and blue pigments and thinning them out with white. Such grays have a lively appearance and lack the dead quality of the grey obtained by the use of lamp-black. They also have a considerably higher reflection factor than similar tints obtained with lamp-black.

Painting.—This question of painting is obviously one that should receive the most careful attention of every architect when specifying the interior finishes in buildings used for commercial purposes, and where the cost of operation is a material factor.

In one very large office building, the suggested change from light buff-tinted ceilings and dark buff-tinted walls to the kind of treatment suggested above would have saved in energy consumption for lighting about $14,000 a year. Under these conditions it would obviously pay to use a paint that can be thoroughly cleaned without injury and to pay the cost of the cleaning at least once every six months. There is hardly any necessity for mentioning the fact that similar economy can be brought about by frequent cleaning of the lighting fixtures. Even the so-called dust-proof enclosed fixtures require cleaning if their efficiency is to be maintained.

It is also obvious that if interiors are treated as above suggested and the windows are equipped with light-directing blinds, so that the maximum daylight intensity is thrown upon the ceiling, a minimum amount of daylight need be used, and this suggests the possibility of reducing the size of the windows, permitting better exterior appearance of the building—all of which is entirely aside from the question of ensuing physical comfort of the occupants, which has been previously mentioned and discussed.

While the above example deals particularly with the lighting of an office, the principles illustrated in this example are fundamental in all systems of lighting for every purpose, and while they must necessarily be modified to meet less utilitarian conditions, they must always be kept in mind, otherwise the character of the building or room will not be suited for the use intended.

Daylighting.—While much of what has been said above is applicable to day lighting as well as artificial lighting, there are a few matters relating particularly to daylighting which deserve mention. It has been said above that the amount of daylight admitted by any aperture is solely a function of the sky-area or area of other brightly lighted surface that can be seen from it. If the daylight cannot obtain access to the window, the window as a lighting source is useless.

It is therefore obvious that, in the architectural design of every building, proper precautions should be taken to make certain that the required amount of daylight will find access to windows or other lighting apertures, as otherwise artificial light will have to be used with the corresponding increase in cost of operation

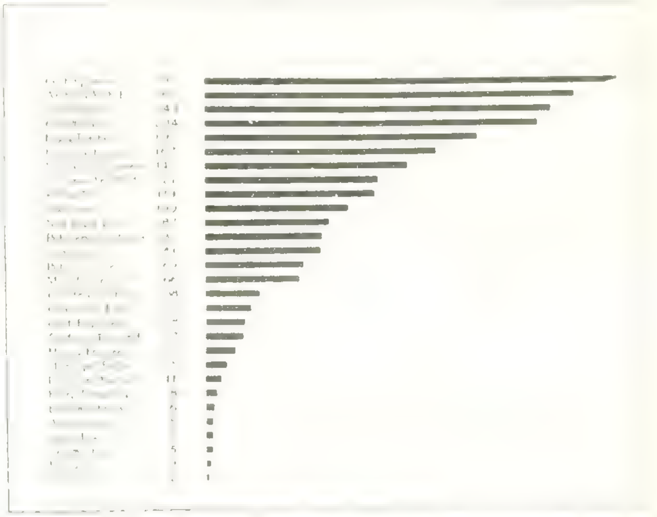
It [illegible] signed and treated that daylight has little or no opportunity to find its way to the windows opening onto these courts or wells. It is a common thing to see designs for elevations of buildings represented with daylight upon them in a manner that will never occur when the building is built. It would seem that, since a building, particularly commercial structures, must be adequately lighted if they are to function properly, their design should be based on the daylight available and the most made of it.

This matter has gradually risen to such importance that we find city laws and state laws making more or less unscientific efforts to correct the difficulties, and the architect is compelled to make his design conform to such laws. Should not the architect himself be the one to take the initiative and to learn at least a little about daylight and how it can be handled.

The subject is entirely too broad and complicated to discuss in detail in an article such as this, but a considerable amount of data has been collected and is available for the architect's use.

Occupations of Engineering Graduates

The accompanying chart, [illegible] bulletin of the College of Engineering of the University of Illinois, shows the distribution of engineering graduates in business and professional occupations. The figures are based on records of 2,453 graduates of the College of Engineering, as listed in the alumni directory for 1916



Occupations of Engineering Graduates of the University of Illinois

Rustless Steel.—The romance of rustless steel, one of the most recent metallurgical triumphs, is given increased prominence with the removal of war control, states the Scientific American. The new metal, with a bright surface and able to resist the corroding effect of air, water and acids without staining, was discovered just prior to the outbreak of the war, and was immediately commandeered by the British Government for use in airplane construction and for purposes where strength and durability, combined with rust-resisting qualities were invaluable. The steel is a Sheffield invention, and was chanced upon largely by accident. A local metallurgist, Mr. Harry Brearly, author of numerous standard works, was experimenting in the armament shop to find a means of preventing erosion in gun tubes. After some of his experiments he noticed that certain pieces of chrome steel had not suffered from corrosive influences under conditions which would have rusted ordinary steel. He followed up this [illegible] worked out and added to Sheffield's metallurgical triumphs. It was applied to manufacturing cutlery

Wall Construction at Norfolk Army Supply Base by Cement Gun Process

The cement-gun was used extensively in the construction of the army supply base at Norfolk, Va. Over [illegible] sq. ft. of "gunite" for walls, roof, etc., were laid by this process. The base consists of eight warehouses and two loading piers [illegible] about [illegible] acres, situated on Hampton Roads near Norfolk. The warehouses have a floor area of nearly [illegible] sq. ft. and the piers have a capacity for docking at one time [illegible] of the largest ocean liners drawing [illegible] ft. of water. The relative positions of the units are shown in Fig. 1. Six of the warehouses are of wood frame construction with gunite walls. The other two buildings were designed to be used for material which might require artificial heat. One of these was constructed of brick and the other of tile. Five of the buildings are 1,400 ft. long each, and the other three are 1,680 ft. long, all of them being 160 ft. wide. In each warehouse a brick curtain wall cuts entirely through the building every 140 ft., projecting above the roof so that a fire originating in one of these buildings would necessarily be confined to one 140 ft. section.

Warehouses 1, 2 and 3 and 6, 7 and 8 are wood frame with gunite walls. No. 4 is of brick, and No. 5 is of tile. No. 5 building, whose walls consist of tile, was stuccoed on the outside with the cement-gun. The construction of warehouses 1, 2 and 3 and 6, 7 and 8 consists of a wood framing as shown in Fig. 2. Wood posts 16 ft. on centers carry girts and caps and roof joists. The roof joists are covered with a 3 in. plank roof covered with tar and gravel.

To the posts and girts there is secured No. 26-A American Steel & Wire Co.'s triangular mesh, which was held in place with wire nails and so-called wire chairs. These hold the mesh securely in place about ½ in. away from the wood. Wooden forms were placed on the inside of the building about ½ in. away from the mesh. Gunite was then shot in place from the outside to a total thickness of about 2 in. The wooden forms were made in movable panels which were stripped any time after 24 hours and moved from section to section.

The total length of walls and ends thus formed with the cement-gun was 19,920 ft. The area was approximately 232,000

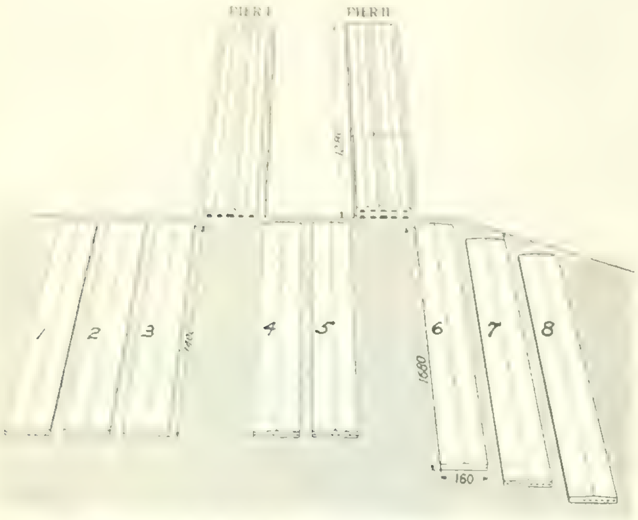


Fig. 1—Units of Army Supply Base, Norfolk, Va.

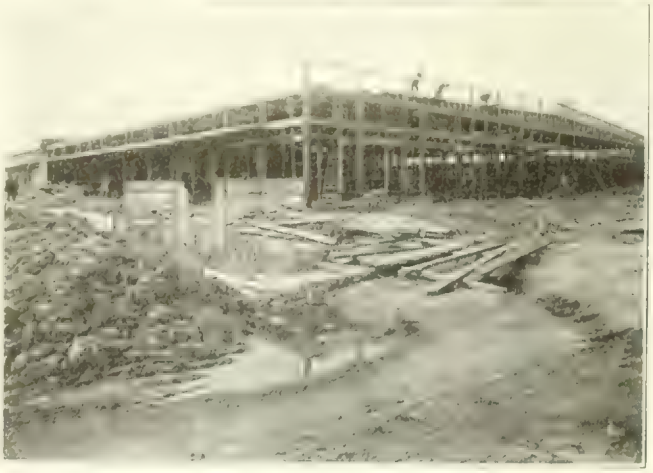


Fig. 2—End View of Warehouse No. 8. Showing Framing.

A part of lower portion of the wall has been formed and is ready for wire to be applied. At extreme left is shown a portion of side wall finished.

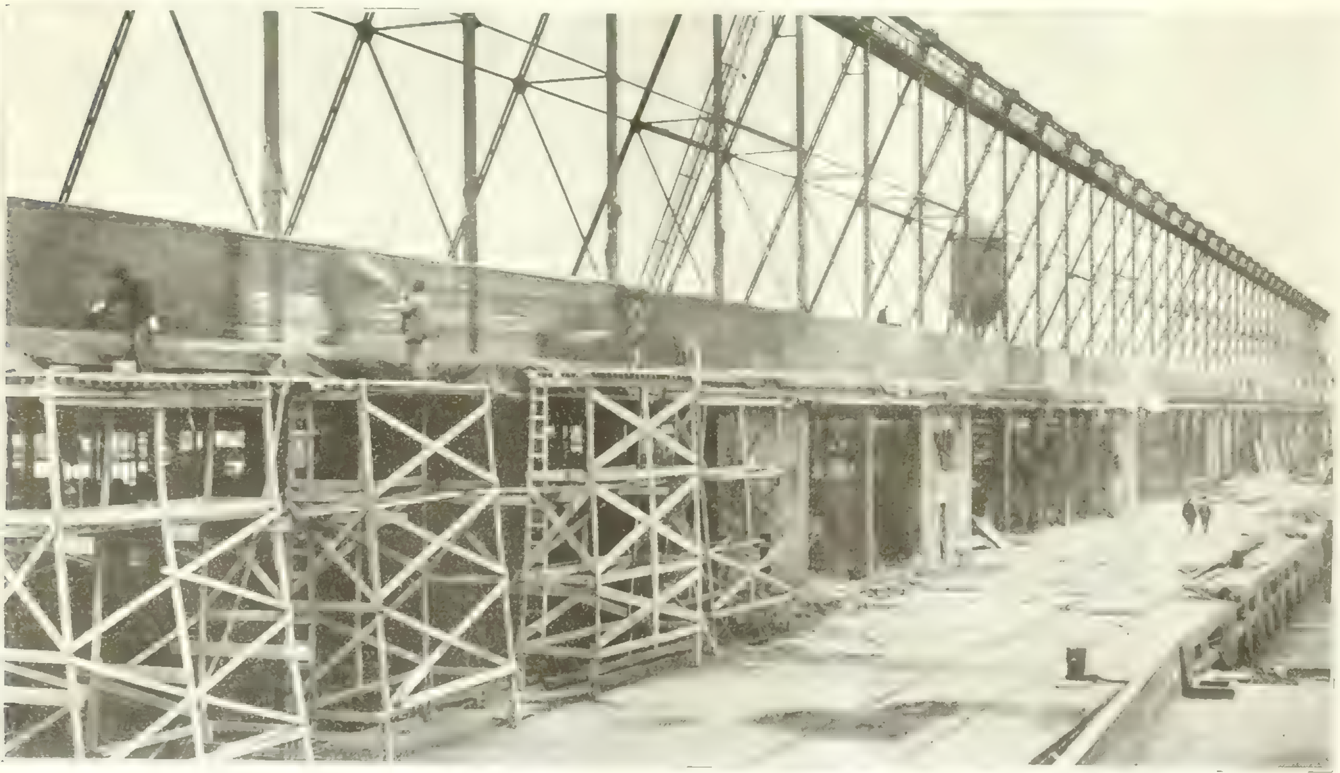


Fig. 3—Outside Wall on Water Side of Pier No. 1.

[illegible] cement-gun finisher is smoothing [illegible] sq. ft. The sand was dug on the site at a cost of approximately 30 ct. per cubic yard.

The two piers extending 1,280 ft. in deep water are covered with sheds of steel construction. Each of these two sheds consists of one center bay and two side bays, the center bay extending above the roof of the side bays in the form of a monitor. There is an outside wall extending from the top of the parapet down about 11 ft., below which is a continuous line of doors. On each side of the center bay and between it and the side bays, and extending from the monitor windows down about 12 ft. to a point below the side bay roof trusses are curtain walls acting as smoke deflecting walls and screens, the purpose being to deflect the smoke from the locomotives which pass through the center bay so as to make it go through the monitor windows and ventilators. The roofs on the side bays are of slow burning wood construction similar to the warehouse roofs. 3 in. plank is nailed to heavy roof purlins secured to the upper chords of the steel trusses. Tar and gravel roofing is placed over the plank. The center bay through which run three railroad tracks has a concrete roof. Every eighth truss in the side bays was made into a fire stop by encasing it in concrete up to the roof line. The cement-guns were used for building outside walls, smoke screen walls, fire stops and roof over center bays. The total area thus covered was approximately 285,000 sq. ft.

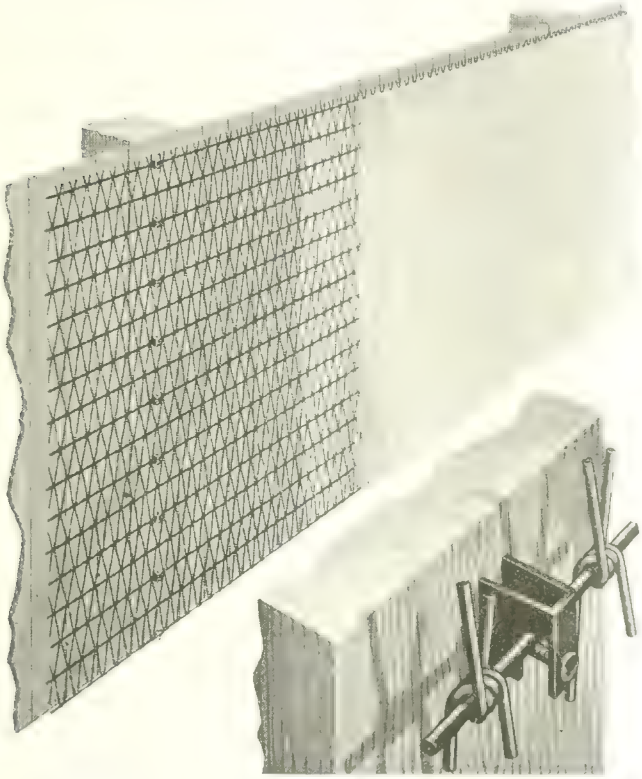


Fig. 4—Method of Attaching Wire, Method of Forming and a Section of Gunite Wall in Process of Being Shot

Figure 3 shows the outside walls at one of the piers in the course of construction. It will be noticed that in a number of places this wall is extended to the floor line. At these points offices and toilet rooms are built into the structure. At all other places the doors are continuous. The high structure shown in this view is used for cargo hoists.

The outside walls and smoke screen walls were formed and shot in the same way as described for the warehouses. The roof structure over the center bay consisted of I-beam purlins 7 ft. centers. Forms were placed between these I-beams snug up against the underside of the flange. The wire mesh was placed in continuous strips running from eave to eave supported ¾ in. above the I-beams on wire chairs with a dip or camber toward the center of the span of about ½ in. The thickness of gunite was 2¼ in.

The cement gun work was carried out by the Cement Gun Construction Co., Chicago, Ill.

Annual Meeting of Concrete Institute.—The American Concrete Institute will hold its annual meeting June 27-28 at Hotel Traymore, Atlantic City, N. J.

Less Theory and More "Horse Sense" in Structural Engineering Courses*

By EDWARD GODFREY

Instruction in the details of structural design, from results that crop out in practice, in the experience and observation of the present writer, in his judgment, is in need of radical realignment. A number of diverse sets of facts that are the basis of [illegible] given.

Some years ago I examined the detail drawings of two theaters which had been made by an engineering concern. [illegible] them. I classified them instead. There were twenty-two different kinds. Some of them were repeated many times. A number of them were so serious that they might have resulted in collapse of parts of the structure. I wrote these up for the benefit of the profession, and the article was published in Engineering and Contracting, Dec. 8, 1915. Previous to this time I had written up a description of a large collection of errors in structural details from different plans that I had examined.* Some of these errors were similar in charac[illegible] principles of stability.

Now it is of no particular [illegible] though holding himself out to be a structural engineer, should make blunders and errors. It is significant, however, that this engineer was unable to see that there was anything wrong with his details, though the builder, a contractor with no engineering training except the horse sense that his experience as a contractor gave him, could see all of my points and insisted, even at much expense to himself, upon everything be[illegible] detailed.

The reader is referred to the published articles to see for himself whether or not the details were faulty.

But the most significant thing of all is that I was in a position where I could refer to no authority to sustain my points and no writing except my own.

In engineering works and in the engineering class a structure seems to be a highly theoretical thing made of perfectly elastic substances that are subject to certain inexorable laws and obey those laws implicitly. But standing supreme over all of these laws is the professional judgment of the designing engineer, which ultimately sustains the loads. In my opinion the professional judgment of the designing engineer is worth practically nothing, unless he can amply sustain it by arguments that will stand the light of day and show that he has plain horse sense as well as some theoretical knowledge. In my opinion the theory of least work, and of redundant stress, and of the elastic behavior of concrete arches, and of secondary stresses due to such causes as the rotation of members on pins due to truss deflection, and most column theories, and several other nice theories, have a value only a little greater than that already ascribed to bald professional judgment.

To come right to the point, there is entirely too much theory, and there are entirely too many theories in engineering works and college teaching and not enough ordinary horse sense.

I could write a book on this subject, showing where engineers, among them some of the highest standing, have designed and discussed structures with their heads away up in the rarefied air of pure theory, while the details, that a man with scarcely any theoretical training could see were faulty, never came into their view nor concern. A few of the high spots will be touched.

When the Quebec bridge was first erected, it was put up with a great traveler as large as a 16-story steel office building. It consisted of two side bents 217 ft. high. Now horse sense tells us (though books and theory say little) that two bents of this height ought to be braced together to prevent their [illegible] engineers provide this bracing? No. Well, what happened? [illegible] bents did tilt over, with their 1,000,000 lb. bur-

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[illegible]

[illegible] and pulled the remaining [illegible] over, killing about 80 men. Did the Royal Commission, investigating the wreck give one warning to the profession against the recurrence of another such disaster? In 8 lb. of dope issued by the said Royal Commission there is not a word about any such possibility. There are some fine new theories, but so far as a discussion of the real cause of the failure is concerned this report is one of the greatest farces in engineering literature.

But the Quebec bridge was rebuilt. A well braced traveler was employed. I had publicly called attention to the blunder of the first and prophesied, that in the rebuilding no such blunder would be made. Again the designing engineers had their heads in the rarefied air of pure theory and high-class problems—a la the most approved literature of engineering. Great problems were solved. The solutions do credit to the designers and to the men who handled and erected the steel. Again a detail was overlooked—a detail that it required horse sense to discover. A great load was to be lifted on a swinging support. The load was to be suspended from a long line of bars and jacked up to place. The lifting scheme was excellently worked out. But why was there a second wreck?

Makers of pails for paint suspend the pail on a bail attached as close to the top as the bail can conveniently be attached. These men know, without being able, perhaps, to tell the reason why, that if the bail is swung, say a half inch above the middle of the height of the pail, you may be able to lift the pail without its upsetting, but the chances are that it will upset and spill the paint. Now, in raising the great suspended span of the Quebec Bridge the "bail" was hinged the trifling distance of $2\frac{3}{4}$ in. above the "center of the pail." The pail upset, after it had been lifted a few feet. Did the profession see this and publish the lesson broadcast so as to warn others? Look for yourself at current engineering publications for the few weeks following the disaster and see if you can find it. I did succeed in getting a letter published which pointed out the real cause of the wreck.*

The Orpheum Theater in New York failed completely and solely because of a monstrous curved girder of 74 ft. of a span and 12 ft. of an offset or versedsine, and this girder was carrying a heavy floor load. The only thing that supported this girder till its collapse was small beams that it was supposed to support. The girder flopped down and pulled with it the whole structure, just a few minutes after 200 workmen had left the building. A large and important part of engineering education is in the hands of engineering periodicals. Was the engineering profession "educated" in the accounts of this wreck? Hear the history. After about a year of investigation and delay a set of the most absurd and inane reports were published that I have ever had to read. No mention was made of the real cause of the wreck. I succeeded in getting in a statement of the cause in Engineering and Contracting, Feb. 18, 1914.

What do the authorities say on the instability of curved girders? Find it, if you can. You will find some nice theories on circular girders and some applications of the same where they are totally inappropriate. Find a warning, if you can, against using a curved girder with simply supported ends. But in current engineering publications after this wreck here is what you will find—some fine spun theory on the dire effect of the twisting of a girder due to deflection of a cross girder that it supports. Bosh!

Four hollow dams have failed because the pressure on the wetted side and the pressure of water beneath them was not adequately resisted by the small weight of concrete in the hollow dam. What do books on dams say of under pressure? If the word of these books is to be depended upon for information on this subject, under pressure did not exist until 1910, or, by majority vote, it does not exist at all. One book, published since 1910, emphasizes the existence of under pressure. Others do not even give it the recognition of mention. I believe that instructors have at last begun to emphasize under pressure. They ought to refuse to teach from any book that does not emphasize the necessity of designing for under pressure.

When the Stony Creek Dam, a hollow dam that failed, was rebuilt, the description of the work stated that the type of dam was in no way responsible for the failure. Yet in the rebuilding the type was changed in these important respects; it was securely anchored to a deep cut-off wall; a lot of concrete was added at the up-stream edge to give stability; a very extensive drainage system was added; and, most radical of all, the drainage system was housed in at great expense to keep it from freezing. When I, a member, attempted to discuss the matter and point out these facts in the proceedings of the American Society of Civil Engineers, I was denied the privilege. This is a sample of the way engineers are being "educated."

There is enough written on the theory of the elastic arch as applied to reinforced concrete arches to fill several books. I have looked in vain for some recognition of one of the biggest single things in this design of an elastic reinforced concrete arch, namely, the bending moment at the spring of the arch and provision for taking care of it. For the sake of saving a little concrete in the arch ring a highly theoretical method of design is employed, and the abutment is assumed to be absolutely fixed whether its mass is sufficient to warrant this assumption or not. This method of design is based on pure theory. The elastic theory stands or falls on this premise, namely, whether or not the deflection of a reinforced concrete beam can be calculated. The deflection of a simple reinforced concrete beam cannot even be closely approximated; hence the elastic theory has no real foundation to stand on.

The use of the simple equilibrium polygon in solving a reinforced concrete arch is so simple and so appropriate to the case that it is a puzzle to me why the elastic theory should ever be brought to bear on the problem.

In reinforced concrete theories are rampant. The rodded column is based, in its use, on theory almost solely. The rodded column is a shaft of plain concrete with a rod near each corner, the rods being stayed at intervals of a foot or so by wires. Sometimes there are more than four rods. Sometimes they are bad enough to have rods in the middle of the side of a rectangle "stayed" with a wire in the same plane. The only thing supporting the use of a rodded column besides pure theory is a lot of misleading tests—tests of columns perfectly centered in an almost perfect testing machine. This is worse than theory because it inspires more confidence. A column, to be a proper member of a structure, must be tough. The rodded column is anything but tough, but the testing machine does not discover this.

In a score or more of bad wrecks rodded columns have proven their utter unfitness as structural members by their failure to sustain their loads and by their behavior in the wrecks. Apart from this I know of only one test of reinforced concrete columns where the thing tested resembled an actual structure and really tested a rodded column in the way it is tested as a building column. This test is described in Engineering Record, Sept. 30, 1905. Here four rodded columns carrying two girders and a slab failed at about 300 lb. per square inch.

The theory of the rodded column does not consider the deflection of the beams and girders connecting in a monolithic character to the columns, and the unknown eccentric stresses at the corners, and the tendency to spall on account of this eccentric stress and the shrinkage of the concrete that compresses the steel and aids in this spalling. On the other hand the same class of theorists who thus ignore facts concerning concrete, a very brittle substance, will split the hair of a gnat in making up theories of secondary stresses in the heavy members of a steel structure. A steel column may have a tremendous unit stress at one corner, due to poor milling, and nothing may result except the peening of the metal. A rodded column having a corresponding condition, due to deflection of the beams, will be sure to spall and may fail and bring down the structure with it. These things are theory in one sense, but they are theory that recognizes facts and is not blind in spots. These facts are eminently common sense, and therefore it is hard to make an ingrained theoretical mind see them. Hence we have the common standards of design in reinforced concrete that are prepared and approved by two classes of men: one of these classes will accept anything that has some authoritative approval, so that it will enable them to compete with other forms of construction; the other class are laboratory investigators who cannot see any difference between an ideal laboratory experiment and a building and who make no attempt to stimulate the laboratory experiment to the building.

The stirrup or short shear member in a reinforced concrete beam is another theoretical creation. Someone with a theoretical knowledge of a truss conceived the idea that stirrups or short shear members, so called, since they look like truss members on paper, can be considered as truss members. The resemblance does not extend beyond the drawing board, for truss members must have perfectly definite and full-strength connections to both top and bottom chords. Stirrups and short shear members have no such connection either to top or bottom chord or flange of a beam.

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*Engineering and Contracting, Oct. [illegible]

No engineer will attempt to explain how a stirrup acts to take its alleged stress nor to explain what takes the shear of a beam between two stirrups or short shear members. Engineers have ceased to discuss both rodded columns and stirrups. They are ashamed of the alleged arguments in favor of these discredited features of design. As proof of this I point to a discussion on these subjects that took place in February, 1915, when I was severely castigated in a meeting of the American Concrete Institute in Chicago. After much insistence on my part the remarks of my critics were written out (most of them) and I answered them. But the men who made the remarks were ashamed of the weakness of their arguments and had sufficient influence to prevent the publication of the discussion. I have been assured repeatedly in the last four years that the discussion would be published, though I have been convinced in my own mind from the start that these men would never let it be published.

I have a standing challenge with the engineering profession to discuss both rodded columns and stirrups and publicly declare the standards of design as regards both, and dependence upon the same, to be outrageous. But the engineer who will dare to risk his reputation by standing up publicly and alone for these absurdities has not yet arisen. In bunches and committees they will pass reports and frame codes that incorporate these false standards of design, but individuals fight shy of being held responsible for something that will not stand the light of common sense.

The reinforced concrete flat slab has given rise to some complex theories that are of no more use than discussions as to how many angels can stand on the point of a needle. The flat slab between two rows of columns is no better than a similar slab between two rows of beams and needs no more complex theories to discover its limitations, interested mathematical prestidigiteurs to the contrary notwithstanding. This simple criterion is the one that should govern both in the making of a formula for design and in tests. But the men who have made the formulas and the tests have ignored this.

About the only practical test on a flat slab building that was a critical test was that made on the Bell St. Warehouse.* This test failed. Investigators have tested interior spots but they fight shy of a row of bays on the outside of a building where no girder exists or a row of bays across a building from outside to outside.

The flat slab and the rodded column, where tested critically, have failed to meet the requirements of the design by which they were constructed.

Now the charge I wish to make against the educators of the structural engineering profession is that by failing either to defend or condemn these wreck-breeders they are failing in their duty. Too much time is given to theoretical discussions that lead nowhere and create false impression of security, and too little time is given to common-sense discussion of the obvious causes of all wrecks, which need no higher mathematics to understand.

The engineering profession is living in a fool's paradise of fine-spun theory, and when a wreck occurs from some simple cause, they spin more fine theory to cover up the real cause of the wreck.

What ought to be done is this: cut out a lot of fine theory or let it lie embalmed in the books where it was born, and give a course in common horse-sense in the details of structural design. Let editors open their columns to a free dission of the indefensible, the bad, the wreck-breeding features of design in reinforced concrete and steel structures and in dams.

I have written this at the request of the chairman of the Committee on Methods and Details of Teaching Structural Design. It is not written to advertise my books or writings. If there was any place else to which I could refer for material for a course such as I suggest I would gladly mention it. I have learned that the way to write books that will not sell is to say in them the things that others have not said and perhaps will not agree with. Any instructor who wishes material for a lecture course in horse sense in structural designing may be able to find these writings in some large library.

Method of Computing Gauge Table for Circular Oil Storage Reservoir with Sloping Side Walls

By [illegible]

In computing a gauge table for a circular reservoir with sloping side walls, it is customary to figure the volumes for each [illegible] bottom.

The [illegible] long and tedious, owing to the reservoir being considered as the [illegible]

Fig. 1.

height above the gauge plate by a constantly increasing increment

[illegible] devised the following formulae showing the relation between succeeding volumes corresponding to equal values of height. By this method succeeding volumes are easily and quickly figured for as many values of h (height) as desired

[illegible] cone, corresponding to a cross section of the reservoir, divided into horizontal sections, whose volumes are represented by:

V_0, V_1, V_2, V, corresponding to equal values of h, as h_0, h_1, h

The volume of V_0 is obtained by computing the center section of height h_0 and diameter d and adding to it the volume represented by the area of the triangle a c e of height h, and width r times the circumference at the center of gravity of the triangle. This volume is given by the formulae:

[illegible]

Then the relation between succeeding volumes is obtained

[illegible]

and

[illegible]

then

[illegible]

also

[illegible]

In like manner any volume is easily obtained when the two preceding volumes are known.

[illegible]

where

A = area of base;

B = area of top

[illegible]

The Architect and His Education*

By CARL F. GOULD

[illegible]

Are we not now about to enter a revolutionary period, or [illegible] of the world's educational history? The term "educated man" does not carry with it the universal approbation it did a few years ago as we all realize. The educated man as such today, is considered erudite. The erudite person we consider, I believe, one who has an avaricious intellectual fund for information, rather inclined to exhibit it, but when deeds and actions are needed, his interpretation somehow does not apply, and he is discarded for one who has maybe a crude solution, but nevertheless one that works.

We know ourselves that the well trained man is, generally speaking, capable of handling problems which the public do not give him credit for being able to solve. The consequence was and still is that many jobs which properly should come into an architect's office, go to contract designers and others who have no training or adequate experience. It is the tragedy of the profession. These men, however, are able to get away with it because, even in their crude manner, they make certain, above all, to bring themselves before the public. The public does not today go out of its way to rout out hidden talent. Talent must come forth and make itself evident or go unused.

In order to analyze this problem we will consider three phases of education which may, we hope, throw some light on this more than unfortunate situation. Education of the student, education of the architect and education of the public.

Education of the Student.—Have we, or our so-called best educated associates, been able to cope with our present-day problem satisfactorily? Has the education of an architect been such, within our experience, or observing that of others, one which has or has not prepared him for the conditions in which he now finds himself—the everyday, workaday world? This, of course, will be answered by each individual according to his interpretation of what is satisfactory. But has the education of the architect had equally successful applicable results, as say, that of the engineer, lawyer, doctor, chemist, etc.?

My answer would be that of all the professions, we have obtained the least apparent success or recognition from the public. If that is so, then the next grave question we must ask, is it the faulty education which we received which has brought our profession so low in public esteem, or have we failed to be instructed in the correct manner in which to exhibit our "wares" to the public, or is there something wrong with the public?

If we admit, which probably some of you do not, that design still has a function to perform even in spite of the receiving public hostility, let us inspect with care the types of architecture we are endeavoring to impose on this practical era of ours. Let us see how these various types of architecture have been the result of our educational process, and whether or not they adequately fit the modern world apparently industrially made

Are not the examples of office buildings on every city's thoroughfare, rising story upon story, accentuating the horizontal members, and topped by a huge classic cornice, are they not architectural perverts? We see their great blank side, but are unable ever to appreciate them from the angle of the drafting board design. Again we have in our midst splendid models in red sandstone, of deep revealed medieval architecture, round-arched, trying its very best to squeeze itself into the requirements of the alert office buildings. Perhaps, after all, our dumb business man may have reason to object, and perhaps we are reaping the fruits of the sins of the early practitioner.

What we need is, first of all, more collective thinking, both on the part of the architect and on the part of the public, and until we do think more nearly alike it is doubtful whether we will make progress towards a permanent architecture. I am sure I perceive protest, protest against uniformity—it has been our slogan above all to be original. The public says, build me a house, I don't care what or how, the only condition I make is, it shall have absolutely no semblance to its neighbor's. Any suburban street in any American town is evidence of this fact. A heterogeneous assortment of every period and type, and the whole commonplace, misfit, sterile and terrifying in its ugliness.

The newer education shows tendencies toward a more rational and greater uniformity of method. It does not discard historic precedent; it brings into the foreground the great masterpieces of the past for inspiration; it analyzes them in terms of the then existing conditions, but above all it teaches us to solve our present day problems into terms of practical requirements, conditions of construction, materials, locality and climate. It remains for our educational process to be willing to search our greater universal tendencies and develop our thought in their direction. However much we older men may be able to adjust our thinking process to the newer order, for the newer order is coming as certain as day follows dawn, we can never do so with the agility of the embryonic architect or the student who is now getting his ground work established. Our schools of architecture should be the most fertile preparatory field for the mold in which he eventually must find a nitch. We can only hesitatingly forecast what this mold will be, and prepare imperfectly our courses of instruction for the boys who will enter it.

The two great conflicting points previously expressed, the following of historic precedent with such close servility as to create misfits; or the utter ignoring of precedent and creation of sterile riot of individuality. No architect's education could, we believe, be considered complete without an intelligent understanding of historic styles, without being able to interpret the subtle fineness of the Greek, the sumptuous dignity of the Roman, or the austere aspiring quality of the medievalist. The student's problems will by no means close at this point. He must be taught the processes of analyzing a problem accurately in terms of its conditions; be able to reduce the complex into its component elements, sense the essentials of a problem, place them in their relative order with equal skill, whether the plan of a workman's cottage, an industrial plant or a courthouse. All the while his thoughts must be shot through with an awakened sense of relative truth in form or proportion. This sense of pure beauty to be attained variously by drawing from life, modeling in clay, exercises in color, and by the abstract study of form or esthetics.

In this analysis of instruction we cannot omit the study of mathematics and construction, the necessity of which is well recognized. Just as the figure of a man fully clothed is his flesh and blood, full of action and joy in living is only possible if the bone framework is sound, so a knowledge of the framework of art or structure of its members must be thoroughly attained.

An awakened sense, therefore, must pervade the whole sequence of education and mold into one mind fabric the visions of man's past achievements, the logical methods of rational determination and a knowledge of the laws of structure. This is indeed a big undertaking as a program of education, and one that can only be imperfectly attained. It is possible, however, we believe, to give a direction of mind to the student which will permit him to more nearly complete the process long after leaving the atelier. There no doubt will be many shortcomings among the future generation of architects, but upon the experience of the past, we believe their education, whether in the office or the school, should prepare them better for the greater opportunities, perhaps the most extensive building era the world has ever seen.

Education of the Architect.—Now finally for the architect himself, we men assembled here, what can we do to help our situation? Let us be a little selfish and look to our own self-preservation. For are we not deserving of some recognition for the self-sacrifice we have been putting into the profession? Willing to give more, to put more into service for the public, and be content to receive so little in recompense? Can we not, with propriety, help ourselves to get added returns and pay out of the few chances that still may be coming to us?

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*Abstract of a [illegible] meeting of Washington [illegible]

Due to the demands upon our sympathies and the necessity of service brought about by the war, the world consciousness has departed from its individualistic isolation; we are now becoming a really united family, not only within our border, but beyond the seas. We are attaining a far greater unity of consciousness.

Architects must take on something of the new enlarged consciousness that has come and is coming to the world. If the practicing architect of today can't do it, someone else will. The contractor or engineer will gradually work into being a flull-fledged practitioner in the newer school. We must, as never before, be alert; we must be prepared to tackle the new problems; we must be prepared to tackle the old problms in a new way. The housing problem, the industrial plant that needs reorganizing and replanning, the farm building. Not only must we be ready to get out our drafting boards with these new problems upon them, but we must be ready to meet the workingman, know him at his local headquarters; we must be ready to meet the overseas shipper and learn his terminal problems; we must go into the country and meet the farmer and become interested with his problems. We can no longer rely so completely upon our architectural plates. We cannot any longer impose upon them problems as previously solved. We must solve their problems on the basis of their own needs, their own ability to pay, and upon the revenue derived.

There are terra cotta plants, wood working plants which need reorganization. We must be willing to inspect them, follow through their special needs and reorganize their plants on the basis of good planning insofar as it interprets their requirements.

Education of the Public.—The architect is by far the best equipped man today to take over these enlarged problems. But the public does not think so, and does not know or care to know so, and he, the architect, is being sadly ignored and is rarely employed in these undertakings. The new order of things is going to require, unless the world's progress is to cease, the solution of innumerable problems such as these. We, as architects, must attain greater public recognition for our ability. We must do it by standing together, working as a unit. We should not seek to hide our talents. It is neither fair to us nor to them. We owe it to the public to exhibit our wares. We must and should keep them informed through the press of our capacity for service. The medium of recognition has, as we know, vastly changed since our fathers' time, when personal contact was all that was necessary to get recognition. We must not forget that method, either; we must meet men as before, though in a larger spirit of friendliness, in the various walks of life. But we should forget our former professional false modesty. At the club, upon the street, in the street car, if the spirit moves us, we should not be ashamed to talk shop to interest a fellow traveler in the subject which is nearest our hearts. You often have to listen respectfully to business men's talks upon business topics, why shouldn't the public listen to us upon our topic, infinitely more interesting than theirs if we take a little pains to make it so. When our fellows do a good bit of [illegible] criticism to adverse comment. Let us for a while at least leave out our adverse comment even upon the most hated rival. Let us see that the press, by persistent effort, will [illegible] above all, let us get into the game in every manner of way that receives the approval of our enlightened conscience. And [illegible] common friendliness.

The greatest opportunities are just ahead. Shall we try to grasp them as a Richardson or a Hunt or a Sullivan, and fail in establishing an architectural sequence? The world will not again stand for it. Our problems are more universal today, and they must be solved in a far more universal fashion.

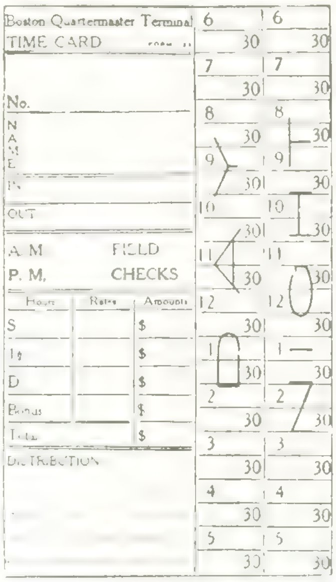
Individuality must count as never before, but it must be the joint individuality of the men in the profession working together with a far larger consciousness.

Time Keeping System on $28,000,000 Boston Army Supply Base Contract

[illegible] feature of the system was the time card illustrated below. A separate card was used for each individual every day. The men in the time checker's booths numbered the cards for the succeeding shift, so that they were available in numerical order when the men entered the booths.

The laborer displayed his button, and the correspondingly numbered card was picked up by the time checker, time stamped in the space marked "In," [illegible] The holder of the card then reported to his foreman who took up the card, after punching the time at which the man [illegible]

The foreman retained all of the cards for his gang until the Government field checker called for them on his rounds [illegible] the men for whom the foreman held cards, and indicated [illegible] the designated space, that he had found and identified the particular individual. The cards were then returned by the checker to the foreman and the same process was repeated in the afternoon.



Boston Quartermaster Terminal
TIME CARD
No.
NAME
IN
OUT
A. M.
P. M.
FIELD CHECKS
Hours
Rates
Amounts
S
1½
D
Bonus
Total
$
DISTRIBUTION
6
30
7
8
9
10
11
12
1
2
3
4
5

Time Card.

At quitting time the foreman again punched the card, indicating the hour at which the laborer ceased work, and then returned the cards to the laborers, who, in turn, passed them in at the time booth as they left the grounds, each card being again time stamped [illegible] space marked "Out."

All cards collected for a given shift, were first submitted to [illegible] who scrutinized them for any evidences of irregularity. For example, the foreman's morning [illegible] stamp indication of the hour at which the man entered the grounds; neither should it be later at night than the time [illegible] There must also appear two punch marks, indicating that a Government check has found the man at work in the forenoon and the afternoon. If these marks were all consistent, [illegible] the man's hours, rate, and pay for the day, were entered upon the card. The information was then transferred to the pay roll sheet so that at the end of the week the several entries could be totalled to determine the amount of pay due.

[illegible] distribution of time for each foreman, it was possible to [illegible]

[illegible] utter absence of disputes as to amounts of pay to which the [illegible] of the week, the several time cards for the individual in question [illegible] conclusive as to which side is in error.

[illegible] project, the amount of pay adjustment, due to errors in pay [illegible]

[illegible] [illegible] [illegible]

In order to facilitate distinguishing various rates of pay the men were numbered in series. For example 1 to 10,000 for laborers, 10,000 to 15,000 for carpenters, 15,000 to 20,000 for iron workers, etc. The number on the card, therefore, gave the pay-roll clerk the clue as to the man's rate, as well as to his trade. Also distinguishing colors were used to identify employees of different subcontractors.

This time keeping system was worked out by Lt. Col. Charles H. Jones, Constructing Quartermaster, Boston Army Supply Base. The William F. Kearns Co., Boston, Mass., was the general contractor.

Suggestions As to What the Canadian Engineering Institute Can Do to Secure Better Salaries for Engineers*

By H. A. GOLDMAN.

The economic and social problems of the engineer can no longer be ignored by the engineering society. No longer can the national society remain indifferent to the present position and status of the profession and still expect the support of the individual engineer. In the United States where the older conservative societies could not or would not open their eyes to see the true and exact position in which the engineer finds himself today, where by means of fictitious tables and diagrams they wished to deceive themselves and the rest of the world into believing that the engineer occupies the same financial level as men of other professions, there it became necessary to organize a new democratic national engineering society. And thus the American Association of Engineers was formed for the purpose of tackling these economic problems which had been ignored by the other societies.

Here in Canada we are perhaps more fortunate in that the existing national society has itself undergone a reorganization, and in the face of existing conditions is said to be willing and desirous to adapt itself to present day requirements and assist the individual engineer in the solution of his economic problems as well as his technical problems. In this respect our opportunities to gain successful results are far better than those of our colleagues in the United States. Since it is far easier to accomplish results when one strong organization is working for the interests of all concerned than when several small groups are working separately, provided, however, that co-operation and action can be secured within that one organization.

The causes which have produced this general feeling of unrest and discontent are nominally two, poor pay and lack of recognition. Actually, however, the removal of one of these causes would gradually also eliminate the other. Give the engineer the proper pay that he deserves, and recognition will come as a matter of course. It is no secret to any one of us that no other thing has contributed so much to the degradation of the engineering profession and no other thing has affected so much the prestige of the engineer as the small financial returns for engineering services. It is idle and useless to blame the public for not giving the engineer the proper recognition. We must not forget that the public at large knows nothing of the amount of training that one has to go through to qualify himself for an engineer. The public has no idea of the nature of the problems that daily confront the engineer and the sound judgment and skill that he must exercise in order to solve these problems. The public knows nothing of these things and therefore cannot appreciate the importance of the engineer in terms of these attainments and qualifications. The public has but one method whereby to determine the value and importance of any commodity, or any class of people whose services the community requires, and that method is by means of the usual medium of exchange, dollars and cents. The standing, importance and prestige of any class in the community is in direct proportion to the value of the services of the members of that class. If, then, the engineers themselves establish a low rate of pay for their services, the public can only take them at their own valuation and can only place them in a class and in a position to which such valuation entitles them. It must be evident, then, that never will the engineers as a class occupy the same position in the community as the doctors or lawyers until they raise the value of their services to the same extent as that of the men of other professions.

When speaking of the services of the engineer to the community, Mr. W. H. Finley suggests that the engineer, because of the nature of his education and training, would be the best qualified to solve the difficulties between labor and capital. It is surprising that such suggestion should be made at all, for what class of labor is there that has sufficient confidence in the engineers, as a class, to entrust them with their financial interests, when as a matter of fact, under the present economic conditions organized labor consider the engineers inferior to themselves, more than that they consider them as a hopeless economic failure.

But there is even a more serious aspect to the matter than merely the prestige and the dignity of the profession, and we must not for a moment lose sight of it. The general disturbances in labor circles which are being reported from practically all parts of the globe are surely going to materialize into at least two definite results. In the first place, labor in the future will receive a far greater share from the products of the industries than it ever received before. And secondly the cost of living is bound to remain high in direct proportion to the increased income of labor, and will never come down to the level of pre-war days. In that event the question naturally presents itself, what is to become of the salaried technical engineer who even before the war had a difficult task to make both ends meet? Organized labor will get a higher standard wage. Manufacturers will get higher profits by charging bigger prices for their commodities. The farmer will get a higher income by selling his products at increased prices. In the face of such conditions how is the engineer going to exist? Is the engineer to be the only victim of circumstances at whose expense the other classes will improve their material conditions, since he will have to pay the increased cost of commodities, while his own income remains the same?

Some remedy must be found to improve these conditions and so far but one feasible, practical and desirable remedy has been suggested, and that is, that the Institute should adopt a standard minimum salary schedule to be paid for various degrees and grades of engineering work. Such schedule to be based on the nature and responsibility of the work, and the technical qualifications required in order to perform such services.

It is realized, of course, that the adoption of such dominion wide standards would at first entail some difficulties in the enforcement of same. But on the other hand we must not forget that the question of pay and salary of the engineer is not an issue between the engineer and the public, or even between the subordinate and his chief. As a matter of fact it is only a family affair, requiring just a little adjustment among the engineers themselves. Because in nearly all cases the pay and salary of one engineer is usually entrusted to the hands and to the judgment of another engineer, and if that second engineer could only have a guide as to what is actually the value of such services as he requires from his applicant, and since such a schedule would serve as a guide, there should be no difficulty in getting a square deal.

Furthermore the mistake must not be made that the demand for a square deal is confined merely to the younger men or to the juniors as some seem to be inclined to think. The truth of the matter is that the profession is underpaid all the way down the line, that many men in full charge of departments with great responsibilities are just as much underpaid as their subordinates working under them, and readjustment must be made all the way up. During the last twenty years the economic conditions of this country have considerably changed. Cost of living was gradually mounting upwards and accordingly all classes of labor have demanded, and received, gradual increases of wages. The medical, law and other professions have followed suit and increased their fees to conform to the increased cost of living. Yet we find in the case of the engineering profession perhaps the only profession of which the members are receiving the same scale of salaries that they received 20 years ago. We must remember, then, that so far as remuneration is concerned the engineer is 20 years behind the rest of the world, and the longer ,we will wait with settling this question, the longer we will postpone it, the farther will we remain behind, and the more difficult will it become to adjust matters, and for this reason it is desirable to take prompt action in tackling this problem.

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*Abstract of a paper read before the Toronto Branch of the Engineering Institute of Canada on Feb. 28, 1919.

But there is even a more serious reason why the Institute should take prompt action in the matter. It is probably already known to most of us that in recent months there has been formed in the United States a strong union organization of engineers and draftsmen, affiliated with the American Federation of labor. That this new organization is making tremendous progress is evidenced by the fact that at one of the regular half monthly meetings of the Chicago Branch, there were 122 new members enrolled at one time.

Whatever the opinion of some engineers may be as to whether or not it is desirable or possible that engineers should form a union, the matter is now an established fact. In the United States, where the engineers are already divided into so many different organizations, such a union will probably do more good than harm. Because at least so far as financial gain is concerned, there can be no doubt but that they will secure it, judging from the accomplishments of other organizations affiliated with the American Federation of Labor. Here in Canada, however, the creation of such a union might cause considerable harm to the profession, in that it would break up the power and strength which it is intended to be concentrated in one organization. If such a union should be formed in Canada, there is no doubt that not only juniors and the younger men would join it, but from the sentiments expressed by some full members of the Institute it may be taken for granted that even such would join the union. That that would be to the detriment and against the interest of the Institute can well be realized. And it is up to the Institute to take immediately such steps as will eliminate the necessity for the formation of such a union here.

I would therefore suggest that a salary committee be appointed tonight by this branch. This committee to study this question thoroughly and prepare a schedule of minimum salaries for engineering services. At the same time the secretary should be instructed to communicate with the other branches and request them to prepare similar schedules. All these schedules to be submitted to the parent society, who would review them and select from them final schedules for the different provinces to be adopted by the Institute.

Correct Moisture Content of Lumber

Shrinking and swelling of wood, as well as warping and twisting, are caused by changes in moisture content. Such changes always take place when the wood is not in equilibrium with the surrounding atmosphere. This state of equilibrium depends mainly upon the humidity of the air and to some extent upon its temperature.

Knowing the average temperature and humidity of any given region, as given by the Weather Bureau records, it is possible to determine the moisture content of wood corresponding to these conditions. Wood dried to this moisture content will undergo the least possible amount of working in that particular region.

The following table, compiled from data secured by the Forest Products Laboratory of the U. S. Forest Service at Madison, Wis., shows the moisture content in wood corresponding to various temperatures and humidities:

When relative humidity of air is. Per cent	[illegible] Per cent	[illegible] Per cent	[illegible] Per cent
20	4.5	[illegible]	[illegible]
30	[illegible]	4.5	[illegible]
40	7.7	[illegible]	3.9
50	[illegible]	7.1	4.9
60	[illegible]	[illegible]	[illegible]
70	[illegible]	10.7	[illegible]
80	17.0	14.0	10.5
90	[illegible]	[illegible]	[illegible]
100	[illegible]	[illegible]	[illegible]

All wooden products in which swelling, shrinking, warping, checking, and opening of glue joints are troublesome should be manufactured at the moisture content and under atmospheric conditions corresponding to the average for the region in which they are to be used.

Uniform Specifications, Plans and Bidding for Building Work

The need of uniform specifications, uniform plans and uniform bidding on building construction is pointed out in "Contracting Comment," a little bulletin published by John Whittaker & Co. of Detroit, sub-contractors for carpentry, interior trim, painting and decorating. The suggested improvements are as follows:

The St[illegible] American Institute of Architects and the National Association of Builders' Exchanges is accepted as the best form of its kind and is more widely known than any other. It is not, however, being used extensively in some cities. Whatever the merits or demerits of that document are, there should be one and only one such document used in any one locality. Contractors may then familiarize themselves with it and architects would only have to mention that such a form of General Conditions applied to the specifications in hand. There are too many "own makes" on the market; it doesn't make for efficiency.

Trade Headings. The order of trade headings in specification books vary as to the number of architects and the number of such books. Trade headings should be arranged in all specification books in alphabetical order or some other accepted and uniform order so that all who use specifications may find any trade heading with a minimum of time and effort turning sheets. Once this is done, its value will be apparent.

Subject Matter Under Trade Headings. Subject matter or paragraphs of reference under trade sections need uniform arrangement exactly as trade headings and for the same reason. In addition, this will have a tendency to corral all references on the same particular subject in one place, rather than scatter them in several places.

Wording.—Wording or expression vary according to the number of architects. It would be impossible to adopt a word for word form for use of all work under all conditions, but there is much standard construction which could be uniformly worded according to the best practice and which would leave no doubt as to the intention.

Uniform Plans: Key of Materials, Symbols, Abbreviations. Some Keys, symbols and abbreviations have by happy chance, rather than agreement, been used alike by the majority of architects, but there is still a great variation which has a strong tendency to confuse and cause error. Once they are standardized, there will be better efficiency in the architect's office and in the contractor's office.

Arrangement of Sheets. There is no general method of arranging sheets in plans. The more widely used method is in the order of plans, elevations, and details, but there is no uniformity. The reader only becomes settled into locating things in a certain way or on one plan when he has to refer to another plan where the order is different, and so he turns several sheets back and forth until he has lost in mind what he was after or has wasted his own time and perhaps another's. This is the same effect of the present arrangement of trade headings and subject matter in specifications.

Details.—Some architects give more details than others, and although it is a difficult matter to lay down any rule as to how much detailing should be done, nevertheless, there could be some helpful uniformity. Standard construction need not be detailed to any great extent, but anything complicated, intricate or expressly different and special should be detailed; this is perhaps more a matter of individual consideration by each architect, but it is worth some working out. Details of plan sheets or elevation sheets should be done away with as far as possible. Their biggest value is in saving paper. Like details should be assembled together on typically detail sheets. This will centralize their location and permit the reader to locate them easier, surer, and with much saving of time without so much chance of overlooking them.

Closing Time for Bids. This is perhaps a small matter at first consideration, but it is nevertheless, of great importance and will have its good effect if settled in some definite way. Instead of bids being due at all hours of the day, adopt one particular hour when it will be known throughout the industry that bids are to be in. This will save much confusion and delay on' the part of contractors who are usually figuring [illegible] on the part of some contractors to this, but the fundamental fact that the owner or his agent is entitled to [illegible] of any important trade is sufficiently important to over-ride any selfish objection. It is not necessary to state in a bid the name of the contractor for [illegible] should be used as a [illegible] every important trade should have the contractor for that work specified in the bid. There is a clear, clean-cut air about such an action. There is a tendency on the part of owners to call for such information before closing contracts; why not make it universal?

Publishing Figures.—A list of competitors and figures in each line for examination at the architect's office by each bidder in that line has an indirect and general tendency to temper or stabilize bids. This phase is purely educational for contractors. There is a time-saver to architects in a plan to give no figures over the telephone and only on call at the office of the architect where the architect's stenographer can look after the matter. How much time does the average architect spend in calls from the several contractors in each line of trade? It is worthy of a trial.

Cement and Concrete Testing for Subway and Elevated Lines in New York City

The work of constructing the rapid transit lines in the city of New York under the contract between the city and the railroad companies, is supervised by the Public Service Commission, and the inspection of engineering materials is carried out by a division organized by the chief engineer. Mr. George L. Lucas, general inspector of materials, has written an account of the methods employed in The Municipal Engineers' Journal, from which the following is taken:

Cement Testing Laboratory.—The cement testing laboratory is located in the center of the Lehigh district, which produces practically all of the cement used on the work, and the force consists of a chief cement tester, one chemist, and six cement testers. This laboratory is fully equipped for making all physical tests and chemical analyses on cement. The samples, weighing 70 lb. each, are taken either from the belt feeding into the bin, or from the bin itself by means of a sugar sampling tube, and they are so taken as to represent the average of the whole bin. When bins have been filled, they are sealed by the inspector, pending results of 28-day tests and analyses. Thirty briquettes of neat cement and mortar are then made and tested for each period of 7 days and 28 days, and 30 briquettes of neat cement for 24-hour tests. Sufficient briquettes are also made for testing through a period of 5 years. Full sets of tests are made for soundness, fineness, setting time, gage water and specific gravity, and also complete chemical analyses are made. Special autoclave tests are also made, but for information only, and are not used for the purpose of acceptance or rejection. Shrinkage and expansion tests are made on 6-in. prisms of 1 sq. in. cross-section. The long-time tests and special tests give additional information as to the character of the cement being produced at a particular mill and aid in making decisions as to the acceptance or rejection of bins of cement where the usual tests come close to the limits of the specifications. When the accepted bin of cement is ready for shipment, the packing, weighing and shipment are supervised by the cement tester at the mill, who furnishes the Commission's specially serially numbered tape ties for sealing bags; these ties serve to identify the cement when delivered on the works.

Concrete and Physical Testing Laboratory.—The main purpose of this laboratory is the inspection and control of concrete aggregates delivered on the works, and testing of concrete, although it is equipped for testing various other materials.

The laboratory and its inspection force on concrete aggregates and concrete are in charge of an assistant engineer. For the inspection of concrete aggregates, inspectors are stationed at the stone quarries, and sand and gravel plants, equipped with apparatus for weighing, screening and grading of stone or gravel; and for sand, with apparatus for determining its grading and silt content. For inspection purposes, the specifications have been graphically represented in standard printed forms for the various types of material by curves showing the limits of coarseness or fineness for each class. Each barge is tested as loaded, and when approved, the captain is given a ticket before leaving the plant, which is collected by the engineers on the works when the barge arrives at the unloading pier to prevent the delivery of uninspected material. Concrete is tested daily on various parts of the work as it is placed in the forms. For this purpose a motor truck is used, carrying standard 8-in. by 16-in. steel cylinders used in making compression test specimens. The concrete for specimens is taken out of the forms, and not from the mixer, for obvious reasons, poured into the cylinders, allowed to set 48 hours under cover and then removed to the laboratory curing room for uniform treatment. Six cylinders are made for each test, three each for [illegible] and 90-day period.

Frequently the spot is marked in the structure from which the sample concrete was taken, and at about the 60-day period a block is cut from the walls or structures, trimmed down into the three test-pieces 6 by 6 by 12 in. at a stone-yard and tested at the 90-day period. This furnishes information determining to a certain extent the relation between the strength of concrete cylinder specimens and the actual concrete in the structure, as the cylinder tests do not represent the actual strength of concrete in the walls or structure but serve the purpose of comparison between concrete made in various parts of the works. The Commission requires in specimens a minimum compressive strength of 1,500 lb. at 28 days, and of 1,875 lb. at 90 days, although the actual strength of concrete in the wall largely exceeds the strength of test specimens. Field specimens, cut from the structure in two months' time and tested at 90 days from date of placing, show an average compressive strength of 3,000 lb. per square inch; often the strength of the specimens exceeding the capacity of the testing machine. As a result of these tests, rules regulating the consistency, times of mixing for the different types of concrete mixers, temperature of concrete before pouring in winter, etc., are issued, resulting in a more uniform and increasing strength in concrete from year to year. Reports on all tests made are furnished the field engineers.

Measuring devices used at concrete mixing plants on the works are regulated by checking from time to time to determine the proper proportioning of aggregates and cement. Local sands along the line of the work are frequently tested and when found satisfactory are approved for use in concrete. When testing sands, not only is the grading taken into account, particularly for local sands, but 2-in. mortar cubes made with the sand in question are compared with those made with Standard Ottawa sand. The mortar cube method of testing sand is undoubtedly the most satisfactory practical test to which a sand can be put.

Special testing and investigation work is also conducted in this laboratory on steels, iron, asbestos, lumber, bond tests, floor hardeners, grout tests, felts, insulators, lumber, brick, joint fillers, mineral aggregates for asphalt and mastic, permeability of concrete, rubber insulation, waterproofing fabrics, integral waterproofing compounds, freezing tests for water service pipes, etc., etc.

Cost of Inspection and Testing.—The cost of inspecting and testing two materials, namely, cement and steel, are cited for a 2-year period as illustrating what may be accomplished. For cement, even with the elaborate system of inspection followed by the Public Service Commission, the cost was 0.8 ct. per barrel, exclusive of tape ties. For structural steel, including mill and shop inspection and chemical analysis made in the Commission's laboratory, the cost was 48 ct. per ton. These costs include all charges, such as overhead, rent, salaries, traveling expenses and disbursements.

France to Expend $40,000,000 for Port Improvement at Havre.—The French parliament has voted an appropriation of $40,000,000 for improvements to the port of Havre. This is part of the national plan of economic reorganization and is destined to place Havre among the bigger European ports for the handling of trans-Atlantic traffic. The work provided for includes a new tidal basin with approaches, 1,000 yards from new quays, the widening and deeping of the Havre-Tancarville vanal and the construction on the left bank of two new floating docks; the building of new breakwaters in the Seine bay with the object of providing a new floating harbor and 3,000 yards of quays, and the construction of four graving docks.

Salesmanship in the Contracting Business*

By LESLIE H. ALLEN.

Smith was the owner of several parcels of real estate and determined that on one of them he would build a large [illegible] building. He called in his architect, and directed him to prepare plans and get bids for construction. In due time the bids came in and, on being opened, it was found that Jones was the low bidder, with a figure of $200,000. Next to him came Brown, with a bid of $205,000. Next came Black, with a figure of $208,000. The fourth figure was that of Anderson, at $210,000, while there were three other figures that were higher still.

Among the trade Jones was known as a low bidder, who was willing to take a chance at anything. If he found that he had figured a job too low, he would endeavor to recoup himself at the expense of the quality of the job or take it out of his sub-contractors in some way or other. Brown was known to be a man who endeavored to give a good job, but was not a very skilled manager, the result being that he could not be relied upon to deliver a building at the agreed time of completion. Black was known to be a contractor whose work was generally good, but who had the reputation of being a "shark" on extras, while Anderson's reputation was good in every way. He was a man who could be relied upon to deliver a building on time and to carry out the specifications faithfully.

Lowest Bidder Gets Contract.—The list of bids was tabulated by the architect and presented to the owner. The reputations of the various competing builders were not known to him. All that he saw was a list of figures and his architect's plans, and he thought, as most owners do, that in accepting any one of these figures he would get just the same building in the same time, with the same quality of workmanship, and the same amount (more or less) of trouble, bother and dispute. He supposed that the difference in cost was due to the fact that the different builders figured different amounts of profit and the result was that he awarded his contract to Jones, the lowest bidder.

Instances like this are happening in every city in the country every year. Good contractors are competing against the poorer contractors on the same footing, and none of them are telling owners or architects the good points of the services their firms have to offer or advancing any reason why they should be given jobs on any basis except that of low price.

If the same owner intended to buy an automobile, he might, if he knew nothing about cars, assume that all were equal in every respect, and that the difference between the prices represented the difference in the amount of profit desired by each manufacturer. The selling of automobiles, however, is not conducted on a bidding basis, but salesmen from the rival firms take pains to demonstrate to the purchaser the good points of their cars, and the owner who would not dream of paying $2,000 more on a $200,000 building to a better contractor will not hesitate to pay $3,000 or $4,000 more for a high-priced car instead of a cheap car, because some intelligent salesmanship has been used in presenting the merits of the higher-priced article to him.

Sell Quality in Construction.—If the same amount of intelligence was shown in the selling of contractor's services, we should not hear of so many jobs taken at ridiculously low prices, and of so many men figuring jobs carefully at prices high enough to pay for good work, with no hope of landing them because they know it is useless to bid against the cut-price competition of the man who intends to scamp the job.

In any manufacturing business the selling department is one of the most important parts of the organization. An efficient sales manager is in charge and properly trained salesmen are on the road all the time talking up the merits of their products. Large sums are often spent on advertising campaigns. On most of our work as contractors we wait until we are asked to figure a job, then we estimate the cost of it and put in our bid and wait to find out whether we are high or low. If we are low perhaps we get the job, but it is most unusual for any effort to be made to "sell" [illegible]

Salesmanship Necessary in Contracting.—In order to successfully sell, a contractor must have clearly in mind what he is trying to sell, and the first point to be emphasized is that in order to sell successfully he must realize that he is not only selling buildings, but also selling service. If a contractor buys a tract of land, erects buildings on it and then [illegible] a contractor who puts in a bid for work to be built on the land of the owner is selling his service and not the buildings (which are a product of his services). In putting in a lump sum bid he offers in effect his services in assembling men and material, in building the work, protecting the owner against accidents while the work is being built and in guaranteeing the total cost of the work. All these are services rendered. They may be rendered well or they may be rendered [illegible] less in his buying and much delay the completion of the job by late arrival of material; but whether well or badly rendered the service is what the owner is paying for.

It is necessary to emphasize this point because the difference [illegible] one. It is not a mere technical quibble but it determines the attitude of the builder toward his job, toward the owner, toward the architect and toward his whole business policy.

Educate the Owner.—The owner does not recognize this fact because nobody has ever told him so. He supposes that whether Jones or Anderson builds the building, it will be built in just the same time, there will be just as much material of exactly the same quality, and the workmanship will be exactly the same. Few builders realize that a well-built job is worth more to an owner than a poorly built one and go out and sell a job on this basis even though by bidding against the crowd they cannot hope to do good work profitably.

Before any contractor starts out on a selling campaign, he must be sure that he can give services which are worth more at a preference. It is possible that one sale can be made by selling talk alone, but the process cannot be repeated with the same owner; unless a salesman's product has a reputation behind it the arts of salesmanship cannot carry him very far. There is as much difference between the service of one builder and another as there is in the quality of shoes, and a contractor who intends to use intelligent salesmanship in the securing of business must be sure that he can "deliver the goods" that he is trying to sell, that is, the services of a good organization that will put up good buildings, of honest material, with good workmanship in prompt time.

Twenty-Second Annual Meeting of American Society for Testing Methods

The provisional program of the 22nd annual meeting of the [illegible] 27 at the Hotel Traymore, Atlantic City, has been announced. The features of special interest are the presidential addresses and memorial sessions on June 24, the topical discussion on [illegible] Institute on Cement and Concrete on June 27. At the joint session American Society for Testing Materials committee [illegible] be presented. The American Concrete Institute report on fireproofing also will be submitted. The following papers are listed for this session: "Later Fire Tests on Concrete Columns," W. A. Hull; "The Stramagraph and Its Application to Concrete Ships," F. R. McMillan; "Effect on Fineness of Cement," D. A. Abrams; "Cements Producing Quick Hardening Concrete," P. H. Bates.

[illegible] Material meeting at which committee reports and papers will be presented include the following: "Preservation Coat[illegible] and Wrought Iron," 10 a. m., Jun 25; "Corrosion and Magnet Analysis," 8 p. m., June 25; "Testing and Apparatus"; "Rub[illegible] Lime and Road Materials," 10 a. m., June 27; "Concrete and [illegible]

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Licensing Building Contractors

The licensing of building contractors was advocated by Mr. S. [illegible] Secretary [illegible] Northwest Master Builders Association in a paper presented at the annual convention of the [illegible]. [illegible] is part:

There are two main objects to be obtained in licensing of contractors, namely, "Raising the standard of contractors" and "Assisting an apprenticeship system." The question may be asked why have the building contractors not been licensed long ago? The lesser craft of the building industry are licensed and we realize it is of great value for the public as well as for the contractor.

We have today young men studying building construction. Some have taken the practical line alone and others both the theoretical and practical. These men are very much interested in building construction and are endeavoring to make themselves as proficient in their particular line as possible. When they start business they have certain ideas which they wish to carry through. The first idea is to get a chance to create, so as to show their talent and ability. But in a very short time they learn that a great majority of the public does not stop and consider their proficiency and skill, but only looks upon the price submitted and generally accepts the lowest price, providing an ample bond is delivered so as to guarantee the work will be completed. It seems the public does not consider a man's moral obligation and ability, which two things are more desired by all material dealers and banks than a few thousand dollars security.

The experienced master builder knows the value of moral obligation and he does not hesitate to pay a premium if necessary to his sub-contractor for such moral obligation.

The owner as a rule does not build often enough to profit by his experience. He sometimes has numerous difficulties but generally forgets about them before his next building operation.

We have heard so much of the fly-by-night contractor. They come and go and some of the most careful business houses and owners pay tribute to them. Such contractors would not have a chance to prey upon the public as they would not be able to secure licenses.

I mentioned in the beginning that there were two main objects. "Raising the standards of contractors" and "assisting an apprenticeship system." If our master builders were licensed as mentioned and paid a fee of not less than $100 (and rather should it be from $300 to $500) we would not have men contracting today and working for wages tomorrow. If a man was sincere and wanted to start business, he would not hesitate to pay the specified license fee, as he realizes he receives a certain protection and can expect to stay in business. By eliminating all that makeshift of contracting the contractor will be more assured of steady work of one kind or the other and he could engage several boys as apprentices and could take upon himself the obligation of training them to be efficient mechanics. This is very essential as we have heretofore received a great majority of our mechanics from European countries; we cannot depend upon that in the future, but we should make such plans and take such steps as to provide against such contingency. Our young men are very quick to learn, but are inclined to be unsteady; if we can hold them in their apprenticeship with one contractor for two or three years at a fixed scale of wages, we will be able to teach them their respective trades in a manner that will be a credit to them as well as to the contractor.

Obituaries

Captain Henry B. Sauerman, who was one of the organizers of [illegible] engineer in the state of Illinois, died [illegible] Chicago, May [illegible]. Captain Sauerman was born at [illegible] Apr. 7, 18[illegible] and came to Chicago when a young man. After obtaining his education at Chicago technical schools and the Michigan Military Academy, Orchard Lake, Mich., he entered the employ of Fairbanks-Morse & Co., where he remained for 11 years, first as chief draughtsman and later as contracting engineer. In 1911 he joined his brother, John A. Sauerman, in organizing the firm of Sauerman Bros., engineers and manufacturers. When the original Company A, Corps of Engineers, I. N. G., was formed on Aug. 1, 1911, he enlisted for three years as a private, being elected captain on July 30, 1912, and remaining in command of the company until poor health compelled his retirement at the end of his period of enlistment. From Company A grew the 108th Regiment of Engineers, which has just returned after giving valiant account of itself on the fighting front in France and Flanders. Captain Sauerman was a member of the American Society of Civil Engineers, Western Society of Engineers and Chicago Engineers Club. In 1918 he was awarded the Octave Chanute Medal by the Western Society of Engineers for his paper "Fortification," which was prepared for a meeting of the society in 1916 and later published as a handbook for army engineers.

Personals

Lieut. E. B. Stearns has been appointed [illegible] manager for the H. K. Ferguson Co., engineers and contractors, Cleveland, O.

C. Grady Cates has resigned as chief engineer of the Roanoke Iron & Bridge Works, Inc., Roanoke, Va., to become chief engineer and assistant general manager of the American Truck Body Co. at Martinsville, Va.

M. Mancuso Ungaro and L. E. Gilbert have become associated under the firm name of Ungaro-Gilbert and will engage in a civil engineering and architectural practice with offices in the First National Bank Bldg., Bound Brook, N. J.

John L. Stanage, formerly engineer for the R. L. Reisinger Co., steel contractors, Milwaukee, Wis., has opened offices at 114 [illegible] Street, Milwaukee, Wis. He will specialize in the design and construction of concrete, steel and timber industrial buildings, foundations, retaining walls and structures of reinforced concrete.

Edgar I. Williams, registered architect, B. Sc. and M. Sc., Massachusetts Institute of Technology and Fellow of the American Academy in Rome; Walter R. Mahnken, registered architect, University of Pennsylvania; and Alfred J. Mahnken, B. Sc. and C. E., Rutgers College, have organized the architectural firm of Williams & Mahnken, with offices at [illegible] E. [illegible] St., New York City.

Industrial Notes

The Stark Rolling Mill Co., Canton, O., announces the appointment of George W. Scott as district manager for the Chicago territory, with headquarters at 1119 Marquette Bldg. Thomas F. Maples has been appointed district manager for the Canton territory.

The Milwaukee Corrugating Co., Milwaukee, Wis., manufacturer of sheet metal building products, has let the contract for a new addition to its factory at Milwaukee, which will cost $150,000. The new section will be 125x240 ft. in dimensions, two stories high, of brick and metal construction.

The Massey Concrete Products Corporation, Chicago, Ill., announces the opening of a Pittsburgh office in charge of A. F. Humphrey, resident manager. Mr. Humphrey will be located at 1405 Oliver Bldg., Pittsburgh, Pa. J. A. Higgs, Jr., has been appointed resident manager of the southeastern district in charge of all sales in that territory, with headquarters at Chandler Annex, Atlanta, Ga.

The Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., as a proper war memorial to the more than 8,000 employes of the company who have entered the service of the Government in the great war, has decided to establish a number of technical scholarships. Each scholarship carries with it an annual payment of $500, to be made in two installments. There will be four new scholarships each year.

The Macomber & Whyte Rope Co., manufacturers of wire rope and wire, Kenosha, Wis., has opened a New York branch at [illegible] Church street, New York City, under the management of E. E. Robirds, who has been with the company for 10 years, having been successively manager of the Pittsburgh and Chicago offices before the opening of the New York branch. A branch office also has been opened at Birmingham, Ala., under the direction of James A. Boope, Southern manager, 805 American Trust Bank bldg., Birmingham.

The Blaw-Knox Co., Pittsburgh, Pa., has taken over the manufacture and field operation of the uni-form system of reinforced concrete floor and roof construction, and the uni-form system is now incorporated in the steel forms department of the Blaw-Knox Co. and will be known as "Blawforms." Nils F. Ambursen, chief engineer of the Ambursen Hydraulic Construction Co., and the developer of the Ambursen dam, assumes the duties of chief engineer of the building form department of the Blaw-Knox Co., and W. L. Church, formerly of Westinghouse, Church, Kerr Co., and Lockwood, Green & Co., engineers, is retained as consulting engineer on the operation of the uni-form system.

Trade Publications

The Jaeger Machine Co., Columbus, O., has issued a new general catalog for its concrete mixers. It contains specifications for the various Jaeger Mixers. Numerous interesting illustrations of construction jobs on which these mixers are being used are included. The same firm also has issued a catalog describing a small mixer, having a capacity of 3 to 4 cu. ft. of unmixed materials.

The North Western Expanded Metal Co., Chicago, Ill., has issued a handbook illustrating and describing the uses of Kno-Burn expanded metal lath in fireproof construction. The applications of the lath to various kinds of construction are fully described and numerous detail drawings are given. The book contains much interesting information on stuccoing, ornamental plastering, overcoating, etc. Specifications also are given for various classes of work.

The 3rd edition of Truscon Standard Buildings just issued by the Truscon Steel Co., Youngstown, O., is a complete revision of previous editions, and contains practically all new matter. The book describes and illustrates types and applications of the Truscon standard buildings built of interchangeable steel panels. The book is illustrated with interesting applications such as factories, warehouses, dining halls, garages, foundries, hospitals, railroad buildings, etc. In addition erection details are shown, also wall panels, steel doors, roof construction, etc.

The [illegible] edition of its Hy-Rib Metal Lath Book has been issued by the Truscon Steel Co., Youngstown, O. The new edition contains many entirely new details of the use of hy-rib and metal lath products. In its preparation the previous publications were completely revised and extensive additions made. The first section of the book is devoted to general information on the properties of hy-rib and metal lath products. Floors and roofs occupy the next section. Here are given many photographic illustrations, types of floors, tests and specifications and tables. The section of the book devoted to walls and sidings is a resume of the use of stucco on metal lath in walls, showing its application to structural steel, wood studding, etc. Under partitions, the various types, such as metal lath with channels, hy-rib without studs and hollow partitions are shown. Separate details and specifications accompany each type. Ceilings, with full details, illustrations and specifications, also tables of use, are covered. Also pages are devoted to [illegible] miscellaneous applications [illegible].

Road and Street Monthly Issue

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Roads and Streets—1st Wednesday
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation and Dredging (c) Quarries and Pits
(b) Rivers and Canals (d) Railways, Steam and Electric
(e) Management and Office System

Buildings and Structures—4th Wednesday
(a) Buildings (c) Harbor Structures
(b) Bridges (d) Miscellaneous Structures
(e) Properties of Materials

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Volume LI CHICAGO, ILL., JUNE 4, 1919 Number [illegible]

Will Common Labor Wages Rise?

The hourly rate of wage of "common labor" has fully doubled in most sections of America during the past five years, whereas skilled labor rates have risen not more than 60 per cent on the average. Does it follow that, if the general level of wages continues to rise "common labor" will not rise as much as skilled labor? We think not.

Prior to the war nearly a million immigrants came to this country every year. During the war the average number was less than a quarter of a million annually. For generations our common labor forces have been recruited mainly from the raw immigrants. Consequently when construction of all kinds is again in full swing, it will be discovered that there is a relative shortage of common laborers. Unless a great wave of immigration sets in, the wages of common laborers will rise again in the near future, and we need not be surprised if they rise more rapidly than the wages of skilled workmen. This is likely to occur even though common laborers remain ununionized for the most part, for the law of supply and demand can be relied upon to effect wage increases wherever there is a relative scarcity of workmen.

In the absence of laws restricting immigration from Europe, high wages and low taxes in America will attract many European immigrants. Indeed, there might be a veritable flood of immigration as there was following the close of [illegible] War. It has been argued that reconstruction [illegible] and high wages in Europe will tend to [illegible] Europeans from coming to America, but this is open to question. Foreign capitalists are likely to remain very timid for a long time. Moreover excessively heavy taxation will greatly reduce their profits, and therefore the funds available for investments. This will probably lead to huge government appropriations for public works, housing, etc., by foreign governments, and it may be followed by extension [illegible] tion of industries in the effort to give [illegible] wages. But there will have to be [illegible] government management [illegible] ments find themselves able to compete industrially with America [illegible].

If foreign governments fail to secure as great an average output per capita [illegible] in America [illegible] management of industries by a government is seen in Russia but we [illegible] land. The prevalent idea [illegible] appears to be that the incentive of individual profit can be abolished without serious decrease [illegible] tivity of workmen. Near- [illegible]

28 Pages = 40 pages

The 28 pages of articles in Engineering and Contracting contain as many words as 40 pages of the size and typography commonly used by other engineering periodicals. Ours is the same size of type and type-page as that of The Literary Digest—easily read, yet giving a large volume of reading matter per page. Our 28 pages of articles would fill 112 pages of the standard 6x9 in. text-book. It would take 10 such books of 580 pages each to hold all the articles printed each year in Engineering and Contracting, to say nothing of our weekly construction news.

sts are laboring under this delusion so far as the masses are concerned. Before it is generally recognized that first class managerial brains are comparatively rare and that governmental methods tend neither to the selection of the best managers nor to a stimulation of their efforts foreign governments will have brought upon their citizens many economic disasters. Each of these disasters will lead to immigration to America, provided we do not close our doors to immigrants.

From present indications congress will restrict immigration, but to what extent is problematical. The restriction will certainly apply with greatest force to illiterates. Hence it is probable that our supply of common laborers will decrease relative to the demand during the next five or ten years. Coincidentally the wages of common laborers will rise, until it may come about that there will be no great difference between the wages of a common laborer and of a skilled workman. This tendency will be increased when common laborers are more generally members of labor unions. Unskilled members of miners' unions have already succeeded in securing wages not far below those of skilled miners. Wherever the number of unskilled men exceeds the number of skilled men in a union, there is certain to be a tendency toward equalization of wages, for labor unions are democracies in which the majority controls. A skilled minority in a labor union can not hope to retain indefinitely a wage rate much in excess of that received by an unskilled majority in the same union.

In the construction field, the majority of the workmen are unskilled. It is probable, therefore, that average wage rates in this field will rise much more than they have risen in the past five years. This spells higher unit costs unless greater use is made of labor saving machinery and methods. Engineers, contractors and superintendents should study machinery and methods as never before.

The Typical Legislator and The Despised Manufacturer

"We believe the state should be authorized by law to manufacture products entering into the public improvements of the state." This is one of the recommendations in a recent report of a joint legislative committee to the Legislature of Illinois. The committee specifically recommends the building of a state plant to manufacture portland cement, because it thinks there may be a combination among cement manufacturers to regulate prices.

We wonder whether this committee knows that the city of Los Angeles some years ago did the very thing that this committee recommends, and that Los Angeles has been unsuccessfully trying to get the state of California to take the cement plant off the city's hands. But why wonder? Was there ever a legislative committee that cared a rap about the actual results of experiments of this sort in other localities? Legislative committees are rarely so ignorant as to need data from any external source. Indeed, they need no data at all, for why was man endowed with the power of reasoning if he must put any dependence on data? A thinker, if worthy the name, should be able to deduce all needed conclusions from assumed premises. Then why worry about experiences with municipally or state owned plants in other states? If those experiences are satisfactory they add nothing to the soundness of perfect deductive reasoning. If the experiences are not satisfactory, so much the worse for the experiences; the deductive reasoning is still sound.

Legislators who have never manufactured anything are ideal investigators of prices and costs of manufactured products, because they approach the problem wholly unprejudiced by previous knowledge. Their minds are as blank as those of the ideal juror, perfectly open to conviction. If, in addition to having never manufactured anything, a legislator has never sold anything save his own services, and has never bought anything save necessities and luxuries for his family and himself, and has never read any articles or books on industrial economics, then he is doubly ideal as an investigator of manufacturing costs and selling prices of brick, cement, broken stone, steel, and whatnot. But to make him triply ideal as an investigator, he must have a wholesome respect for his own astuteness and a corresponding contempt for the knowledge of mere manufacturers, engineers and others who have spent their lives in studying the economics of their narrow specialties.

Breadth of intellect, you should understand, is attainable only by men who know next to nothing about anything in particular; for only to such men is given the power to secure quickly a complete knowledge of anything they choose to investigate. The ordinary business or professional man grovels his years away in some little acre, mole-like in his blindness, whereas the man of "general knowledge"—the typical legislator—soars above him in the ether, his eagle-eye sweeping from distant horizon to distant horizon. There he soars and soars, never weary of soaring, nor of making the despised earthings "soarer" and "soarer" in their envy of his soaring.

Secretary Houston's Opposition to a Federal Highway Commission

Secretary Houston of the Department of Agriculture, has issued a statement giving his reasons for opposing a Federal Highway Commission to take the place of The Bureau of Public Roads. On another page Secretary Houston's statement is given in full. His reasoning, it seems to us, is not sound. Naturally the Secretary of Agriculture does not relish the idea of having the scope of his authority decreased as it would be were The Bureau of Public Roads converted into a separate Federal Highway Commission. Still it would seem that the Department of Agriculture would remain a large enough organization to give the most ambitious of secretaries a very busy time of it, even if he had nothing at all to do with the general management of federal road matters.

As we stated editorially several months ago, The Bureau of Public Roads has grown so great and important that it should remain no longer attached to the leading strings of the Secretary of Agriculture. We are glad to have the secretary's reasons why the leading strings are desirable, for his arguments are, without exception, so weak as to defeat his purpose.

The Secretary, to begin with, undertakes to associate the general plan for a Federal Highway Commission with a particular bill introduced in the Senate last February. But most of the advocates of a Federal Highway Commission do not approve of all the provisions of that bill. For example, the bill provides for at least two federal trunk line roads in each state. Why have any federal roads at all? Why not continue the co-operation of the federal and state governments? The proponents of a Federal Highway Commission have never voted to change the existing plan of co-operation. What they have agreed upon is the wisdom of converting the Bureau of Public Roads into an independent department.

Secretary Houston next proceeds to defend the work thus far done by the Bureau of Public Roads, but it needs no defense. Our contention is that the bureau has grown so large and its work has become so important that it should no longer remain under the general supervision of a secretary of farms. Such a secretary necessarily has neither technical nor administrative knowledge of a kind that makes him highly efficient as the head of a great highway department. He points to the fact that he has selected one of the most capable of state highway engineers as the head of the Bureau of Public Roads; but one naturally asks why a man of such outstanding ability, both as an administrator and as an engineer, should be held in subordination to any secretary of agriculture. If the bureau were insignificant in size and importance, it might be well to continue it as a bureau. Nearly every one, save the secretary of agriculture, realizes that the Bureau of Public Roads has already evolved into a department that should function separately.

Secretary Houston even goes so far in his search for arguments as to speak of the added expense of having five federal highway commissioners, each at $10,000 a year. As for ourselves we doubt the wisdom of having more than one commissioner, but if there were even 10 at $10,000 each, their salaries would be only a trifle compared with the total annual expenditures to be made for roads by the government.

Secretary Houston raises the question of legal complications that might ensue were the Bureau abolished. He doubts whether the states would quickly change their laws so as to provide for state co-operation with a Federal Highway Commission. If it should prove legally impracticable to continue the present co-operation between federal and state governments without a change of state laws to correspond with the proposed change in federal road laws, then, pending such changes in state road laws, the Bureau of Public Roads should be kept in existence for a few years. But a Federal Highway Commission or Department should be created at once, and it should be assigned such functions of the Bureau of Public Roads as could be assigned without interfering with co-operation under existing state laws. This might cause some complication and added expense during the transition period of about two years. Certainly no such temporary trouble should be allowed to stand in the way of a permanent betterment.

The Secretary closes his argument with the bugaboo question: "Why at this stage introduce complications and embarrassments?" The answer is that the embarrassments will be mainly imaginary and that the complications will be wholly temporary, whereas the resulting gains will be entirely real and permanent.

Is Experimenting With New Designs of Pavements Justifiable?

A reader suggests that we comment editorially upon the waste of public money in repeating experiments with pavements. He says:

"The method of today in highway departments seems to consist principally of experimenting with experiments that have already been experimented with to the detriment of the pocketbook at large and to the highways in general.

"When one political regime is in power, with its particular appointees, road construction is approached from the beginning and various types of construction tried out. About the time the highway and paving problem has been solved by this particular administration, election comes along and a new set of officials tackle the highway problems without regard to past experiments, go all over the same ground, taking about the same length of time as their predecessors and then comes another election and so on, ad infinitum.

"There are standard types of street pavements and of country roads that have proved their worth by 40 years of service under all types of traffic. Why, then, do communities persist in the search for an impossible Elysium branded as 'permanent' when every sane person knows that there is no material, not even steel, that will last forever?"

Our correspondent himself indicates one of the reasons why experiments are so often repeated, namely our elective system that results in frequent changes of highway personnel. Another cause of frequent change is the inadequacy of salaries paid to city, county and state engineers and other public officials. Finally, there is not enough co-operation among highway departments, both in conducting experiments and in making the results available to all highway engineers.

While it is true that there are "standard types" of pavements that have demonstrated their merits for many years, the need of experimenting with pavements will never cease; for not only may good types be improved, for a given traffic, but traffic conditions are changing to such an extent that the design of pavements must be modified.

In experimenting with new, or even with slightly modified, designs, it is a good economic rule to make the early experiments on a relatively small scale. Engineers have often departed from this rule, but usually to their sorrow. It is not necessary to build a hundred miles or even one mile of road of new design to test its economic merits. A fraction of a mile of road, carefully studied over a period of years, will usually serve as well for test purposes as if it were a hundred times longer. Then if a large number of short test stretches are laid upon different soils and for different densities of traffic and if careful maintenance costs of each stretch are kept, valuable information is secured at relatively slight cost.

Some engineers are so conservative that they make no tests at all, "letting well enough alone." Other engineers go to the other extreme, and are easily persuaded to build many miles of roads that are really experimental. In the latter case, they usually think that no experiment is involved because somewhere a similar road has been in use a year or two and has apparently given satisfaction. They fail to realize that "satisfaction" for a short period may turn into dissatisfaction over a long period, and that "satisfaction" under light traffic may become "disgust" under a somewhat heavier traffic.

Conservation in adhering to types and designs of proved merit is usually regarded by inventive minds as being old fogeyism; but it is not old fogeyism unless it is carried to the extreme of refusing to experiment at all. A first-class administrator is constantly experimenting, but he does it "on the side" or in a small way. An inventor often makes a very poor executive, not only because he is apt to make changes continuously, but because the changes are of a wholesale character.

Mark Twain's biographer says that Twain lost a fortune through "backing" an inventor of a typesetting machine. The machine that he had was a success, but he kept changing it, always deferring putting it on the market till he had completely "perfected" it. Finally another inventor, Mergenthaler put his still imperfect machine on the market, and the inventor for whom Mark Twain was the "angel" lost his golden opportunity.

There is no such thing as perfection in the field of economics. Hence the never-ending effort to reduce unit costs. Hence, also, the wisdom of continuing to use that which has been shown to be good, while experimenting on a moderate scale with that which promises to be better.

The Up-to-Date Drafting Room

To the Editor: Few realize the progress which drafting has made in the last generation. Even in engineering circles the work does not receive proper consideration. Thirty years ago the drafting and construction work went hand-in-hand. In other words, the designing and planning was not nearly so important a function as it is today. Projects now are thought out, designer and planned in every detail and carefully estimated before proceeding with construction. This is why drafting, which is, properly speaking, engineering, has become such a highly developed art, requiring an immense amount of technical knowledge and practical experience.

Drafting is not a trade as it was so considered years ago, because it is not physical labor so much as it is mental. Therefore drafting is actually a profession, regardless of the fact that practically all draftsmen are employed and not in business for themselves. The profession of drafting should not be separated from engineering because it is the engineering profession just as much as is the work of construction. It is unfortunate that the relation of drafting to engineering is not better understood by engineers and draftsmen and the public. It is a great mistake for any one to think that drafting is a menial occupation or is the unimportant part of engineering. Drafting, considered as a whole, is the most important part of engineering for it is in the preparation of the design and detail drawings that the economy of the whole scheme or structure is determined. It is the work in the drafting-room that decides the success or failure of most all engineering projects.

In order then to correct the misunderstanding and avoid the existing confusion regarding the draftsman and his work, the word, draftsman, and drafting-room, had better be eliminated. Every one recognizes a designer or capable draftsman as being an engineer, so why not call them engineers? Likewise the drafting room, the engineering department? As it usually is so styled in most all correspondence. This to me seems the only way to bring order out [illegible] and draftsmen.

There is considerable discontent in the various drafting rooms throughout the country which has been brought about partly through this inclination to separate the draftsman from the engineer and partly on account of low salaries of draftsmen as compared to laborers and tradesmen [illegible] possesses the intelligence and ability to design and construct a machine receives a compensation frequently much less than the man who merely operates the machine. Employers are striving to eliminate the causes of unrest among their workmen and this is one which must be considered and remedied or else these men through their various or- [illegible] will bring it forcibly to their attention. Employers must [illegible] the good salaries are not the only thing in which draftsmen are interested.

The drafting-room must first of all have the very best system of lighting and this should be determined in each particular case by an expert in illumination. Frequently drawings are made which require working to 1/100 in., therefore it is highly important that these men have the very best lights to avoid eye strain.

Good drafting tables should be provided and other accommodations for the men who are doing this very important work. There seems to be a desire all too frequently to economize on the drafting-room equipment, hence so many common board tables on wooden horses, which is a great mistake. The saving made in the furniture and fittings is lost many times over through the discontent of the workman. Special instruments and labor saving devices are sometimes the means of considerable economy.

For general use in an office, where there is a demand for such instruments, a pantograph, plainimeter, parallel rule, a set of ship curves, a calculating machine, etc., etc., are well worth the expense. In fact a drafting-room not equipped with these instruments and particularly with drafting machines, is about as up-to-date as a large shop without automatic cutting machines or an oxy-acetylene welding outfit.

Draftsmen are too close to the executives for the latter to allow a condition of unrest or discontent to prevail. Their loyalty on the whole is without question and since their work is so close to the office safe, so to speak, it is necessary that harmony exist between the executives and the engineering department. Otherwise the unrest may take the form of I. W. W.ism or Bolshevism, which means nothing less than the destruction of all organized industry and government.

Draftsmen must do their share of the work of putting drafting on a plane commensurate with the dignity it deserves, which is equal in every way to that which engineering enjoys. There is entirely too much criticism among draftsmen. Criticism of another's work is quite out of place unless it comes in line with one's duty and then it must conform with what is right and just. A great amount of time is spent by some draftsmen in talking about the various "jobs" they have held and petty treatment received. If this talk was properly directed towards raising the standard of the profession, instead of lowering the dignity of the work it would on the other hand proportionately raise it. "Jobs" and "wages" must be superseded by "position" and "salaries." Avoid the employment agency as many of the best companies will not take men from any agency which is in business for profit. Join some engineering society which offers this service or use the U. S. Employment Bureau.

Draftsmen should mix up more with other people and not live such narrow lives, confined by the four walls of the drafting-room. To make yourself known and your work understood does not mean to be domineering or arrogant. The dignity of engineering will be better preserved by being modest, but the economic status is not raised by hiding your light under a bushel.

ROBERT W. SHELMIRE.

Chicago, Ill.

Activities and Aims of Engineers and Draftsmen's Union

To the Editor: In view of the considerable discussion in the past months concerning economic and social phases of the life of engineers and draftsmen and in view of developments along various lines in attempts to better the situation generally, it may be of interest to note that representatives of the International Federation of Engineers and Draftsmen's Unions were given a hearing at Washington by the Board of Railroad Wages and Working Conditions of the U. S. Railroad Administration, May 12 and 13. In behalf of engineering and architectural employes in all branches of railroad service, both in field and office, a brief was presented to the board and testimony given as to its subject matter. This brief embodied four principal suggestions which we consider to be of prime importance at this particular time of uncertainty, and we requested their adoption by the board in recommendations to the Director General.

One of these was the request that in case the widely rumored reduction of forces should occur (it has already) a system of pro rata furloughs should be instituted, to affect all employes who are classed as permanent, making it possible for many men to tide over emergency periods and for some to use their off time to find permanent location elsewhere. These latter would naturally be taken from the rolls and thus automatically reduce the pro rata lay off for the remainder.

When this method was suggested in our organization for the ship yard draftsmen it was approved by them almost without exception as preferable either to flat discharge or practically enforced acceptance of lower ratings.

A further request was for the establishment of regulatory committees to be composed of the more responsible technical supervisors and representatives of the managing officials. Such committees by applying the schedule and budget principle to work which is to cover somewhat lengthy periods could greatly reduce the tendency of railroad work to go by fits and starts, and be of great value in breaking the disruptive force of periods of financial depression. The fact that projected railroad construction and the men at work on it usually feel the first effects in times of stringency hardly needs repeating, but the fact of continual danger in breaking up field and office organizations and throwing the men into the market to compete against and under cut those left at work anywhere in the country warrants frequent repetition.

Any abrupt and continued cessation of plan-making by engineers and architects is bound to have results reaching far out into labor and business fields. Mines, factories and endless industries feel the bad effect, and it is this which we hope to minimize through the policies outlined.

The third point of the brief was the creation of office committees, similar to those in many industries, which will put into operation the classification of technical employes and the standardization of their positions, so far as may be accomplished. It was suggested that machinery be adopted for this purpose similar to that instituted by the Macy Board in the private and government ship yards. In this way matters of classification and the adjustment of differences are taken up with supervisors and department heads of managing officials and in rare cases of special difficulty with a regional examiner appointed by the board.

And, finally, there was presented the following salary schedule, which we feel is very moderate:

MINIMUM SCALE.

	Minimum salaries per month
Chief draftsman	$300.00
Leading draftsman or squad man	250.00
Draftsman, Class A	210.00
Draftsman, Class B	175.00
Draftsman, Class C	135.00
Tracer, Class A	125.00
Tracer, Class B	75.00
Assistant engineer [illegible]	250.00
Assistant inspector, Class A	200.00
Assistant inspector, Class B	150.00
Instrumentman	210.00
Rodman, Class A	175.00
Rodman, Class B	150.00
Tapeman, Class A	125.00
Tapeman, Class B	100.00

Regular hours to be 7½ hours on five days of the week and four hours on Saturday, making 41½ hours per week.

No overtime except where absolutely necessary, and at the option of the employes, and time and one-half for all overtime ordered or made necessary.

All traveling and other expenses incurred for railroad business, and also expenses attached to moving headquarters, allowed.

Civil service rules to apply regarding vacation, holiday and sick leaves.

No salaries now in existence to be reduced.

This schedule is slightly lower than that of the Macy Board award to marine draftsmen and it is certainly small when compared with the more than 100 per cent increase in living costs in the last 5 years.

It may be news to many of your readers that 28 locals were represented in the convention of our international in New York on April 1st. This is a comparatively young organization and is rapidly expanding in the United States, Canada and Central America.

Publicity Committee Draftsmen's and Designers' Union, Local 14, Chicago.

[Editor's Note.—In a circular issued recently by the Chi cago local of the above mentioned union it is stated that the International Federation had over 5,000 members in 25 locals. The Chicago local alone had over 700 members. The following is quoted from the circular.]:

"During the last few years, technical engineering organizations have come into existence, having for their announced aims and purposes the economic betterment and welfare of technical men. Our technical journals are publishing many articles bearing on this subject. Even the older purely technical and scientific societies had begun to recognize the great need for concerted economic activity. But the lamentable situation disclosed at the hearing (of March 31, 1919) before the government wage board clearly shows that these types of organization are not so constituted as to attain those announced aims. In our opinion, if an organization is to succeed in being of real benefit to the rank and file, two things are imperative. First, the constitution of such an organization must be so drafted that its control will never fall into the hands of men whose interests are not bound up in its success, for it is obvious that if its officers are men of independent means, there will be no assurance that the success or failure of the organization will be vital to them; second, the organization must have the backing of a large body of organized workers to give it force.

"As to the first requirement, the men in the rank and file who have been able to read the full proceedings before the wage board are firmly convinced that what we most feared has happened to the very organization we expected most from, namely, the control has passed to the higher-ups, and is being used more in their interest than ours.

"Wherefore, many of us have, in the quoted words of Mr. Dermody, 'looked into it for ourselves,' with the result that this first requirement is met by the organization of an International Federation of Draftsmen's Unions, whose constitution is so drafted that its control must always remain in the hands of men who depend upon their salaries for a living; and the second requirement is now fulfilled through the affiliation of our union with the American Federation of Labor under a charter giving jurisdiction covering engineering and architectural workers in field and office."

Use of Calcium Chloride as Dust Preventive on Gravel Roads

The Connecticut Highway Commission has obtained excellent results from the use of calcium chloride as a dust preventive on gravel roads passing through sprasely settled sections. The methods employed in making the applications are described by Mr. W. Leroy Ulrich, Superintendent of Repairs, of the State Highway Commission, in Public Roads, from which the matter following is abstracted:

The material is put up in metal drums, holding about 350 lb. per drum, and costs at the present time between $20 and $30 per ton at the point of shipment. The price varies with the amount purchased. The drums will be painted by the shippers without extra charge if requested. If this is done, material may be stored for future use in any reasonably dry place. If it is not done, the drums, being very light-gauge material, quickly rust out, exposing the chloride to the air, from which it immediately attracts moisture and solidifies, in which form it is very expensive to handle. If properly sealed and handled, when the drum is opened it will roll out in the form of kernels about the size and appearance of popcorn.

In order to obtain the best results the surface of the road to be treated should be kept in shape by the use of a drag for about two weeks previous to the application of the material. This will insure proper cross section and a reasonably smooth surface for receiving the material. The application may be made by laborers spreading with shovels, but this is not satisfactory on long sections as it is too slow and expensive. A uniform distribution can not be obtained by this method. Any ordinary lime sower will spread the chloride, but it is economical to purchase a special machine for this purpose. These machines may be purchased in different widths for use with a single horse or a pair.

In making application with the use of horses the drums are distributed along the road at regular intervals, one at a point if a narrow machine is used, and two if the wider. The necessary interval is determined by the amount of material to be applied. About 1½ lbs. per square yard is necessary for the first application, which should be followed by a second treatment at 1 lb. per square yard. The interval between applications depends upon the quality and condition of the surface on which the material is spread and the character and volume of the traffic carried. Under moderate traffic a good surface would not require more than two applications per year; under heavy traffic three may be necessary. The best results are obtained if the material is spread on the road after a rain, when it is wet, as a better penetration is obtained at this time.

In making an application with a 2-horse machine with a spread of 10 ft., two drums are distributed every 220 ft. This machine will hold the contents of two drums and after filling is run up one side and down the other and then up the middle of the road, stopping at the point where the next two drums have been placed. This applies a little less than 1 lb. per square yard on each edge of the road and nearly 2 lb. on the center 10 ft. This method has proven more satisfactory than making an even distribution over the entire surface. The same method may be followed with the one-horse machine.

In order to eliminate the necessity for the distribution of the drums, the machine may be hauled behind and fed directly from an automobile truck. Eighteen drums may be carried on a 3-ton truck, which, running continuously in one direction, will cover one width for about 6,200 ft. Three trips will complete the treatment of this length of road. This has proven a little more economical than distributing the drums and spreading with horses.

During the handling of the material, all workmen should wear rubber boots, as the chemical action of the chloride is very detrimental to leather. It is also well to provide cotton gloves, otherwise the hands will soon become sore. The hoofs and hocks of the horses, which are working on the distributor, should be cleaned and greased night and morning. After the chloride is melted on to the surface of the road, it will not cause injury to horses or to automobile tires.

Proper application of calcium chloride results in a smooth and practically dustless surface, making a road with almost ideal riding qualities. While not considered as a binder this treatment does toughen the surface, making it less liable to ravel. One of the great advantages of roads treated in this manner is the ease with which the resulting surface may be maintained. All that is required is a light dragging at intervals in order to keep the surface smooth. On account of the moisture held in the surface this may be done whenever necessary without waiting for a rain.

The surface of most gravel roads softens up in the spring when the frost is leaving the ground and the calcium treatment does not overcome this condition. The results in Connecticut show that the treated roads do not mud up any more than untreated roads of the same quality and not as much as roads of this quality which have been treated with a nonasphaltic oil. The continued use of chloride has an accumulative effect. After two or three years, with two applications per year, the effect of the material is plainly noticeable in the spring, after the road has settled.

During the year of 1918, with labor at approximately $2.75, teams at $7.50, 3-ton trucks at $25, the cost of this treatment in Connecticut per square yard per year (two applications) has been $0.031, divided as follows: Chloride $0.026, handling and application $0.005.

Highways Must Be Built to Sustain Motor Truck Traffic.—The use of the motor truck has exceeded all prophecies. The war has given it its place. It is a means of transportation co-ordinate with train and boat. Highways must be built to sustain it. In each of our three previous reports we have plead for the building of more durable types of pavement. We now have in this state [illegible] miles of durable pavement of the concrete, brick, asphalt block, etc., types, as distinguished from the less durable waterbound macadams, etc. Henceforth, except in unusually isolated communities the durable type will be the only economical type. The higher first cost of the former will be offset in a very few years by the higher maintenance cost of the latter under heavy traffic. There is no further excuse for building semi-durable pavements in or near settled districts. Their "cheapness" has, with the advent of the motor truck, become extravagance.—From the last annual report of H. E. Breed, [illegible] Deputy Highway Commissioner of New York State.

Highway Transport Engineering: A New Field for Engineers

The United States [illegible] a period of phenomenal [illegible] of highway improvement and motor transport. This country has witnessed a rapid growth in the utilization of the motor vehicle as evidenced by a registration of [illegible] motor vehicles in [illegible] and [illegible] in 1918. While in 1908, a motor truck was rarely seen on American highways, in [illegible] not less than [illegible] were in use in the United States, motor trucks constituting from [illegible] to [illegible] percent of the registered motor vehicles in the several states. Highway improvement has not kept pace with the increase in the utilization of motor vehicles. The fundamental basic axiom that economic highway transport is impossible without good roads should be fully recognized. A review of the present status of highway improvement in the United States indicates that there are about 2,500,000 miles of rural highways; that 12 percent are classified as improved, and that about one-eighth of 1 percent are suitable for trunk highway motor truck traffic.

The human, economic and social forces working for the improvement of highways and motor transport development in the United States are of such powerful character that nothing can permanently restrict progress in the construction of good roads and the growth of highway transport. Through no other agencies is it practicable to stabilize urban and rural development, to appreciably reduce the high cots of living as far as food stuffs are concerned, to bring the producer and consumer into close contact, and to solve some of the vital labor problems.

In his presidential address May 14 at the annual meeting of the National Highway Traffic Association, Mr. Arthur H. Blanchard, consulting engineer, pointed out that this development of highway transportation has created a demand for men having knowledge of and trained in a new technical field, which he designated as highway transport engineering. Mr. Blanchard outlined this new field as follows: Fundamentally, this branch of engineering deals with the science, art, economics and business of highway transportation of passengers and commodities. In the opinion of some, highway transport may not be considered as belonging to the field of technical training and education. On sober thought, however, it will be seen that this branch of knowledge comes well within the classic definition of engineering embodied in the Royal Charter of the Institution of Civil Engineers of Great Britain, which, in part, is as follows: "The art of directing the great sources of power in nature for the use and convenience of men as the means of production and of traffic in states both for external and internal trade."

The breadth of training for this branch of engineering should be far more comprehensive than has been considered essential for many technical branches. Breadth of knowledge is essential, as the highway transport engineer must, in many fields, deal with social and economic conditions and must always have before him the fundamentals of sound business methods.

Comprehensive courses in highway transport engineering to be offered by educational institutions should include the following basic fundamental subjects: Economics, political economy, social science, business and contract law, scientific management, business organization, cost accounting, interstate commerce, marketing and distributing systems.

The highway transport engineer or manager should have a knowledge of all of the following special subjects:

History of American transportation and rural development. English highway transport methods and legislation. Interrelationship of highway, railway and waterway transportation including: Influencing factors of distances, rates, kinds of freight, equipment. Port, terminal and warehouse facilities. Interrelationship of highway transport, good roads and rural development "Back to the Farm" movement, which is a function of three fundamentals, namely, building systems of good roads, utilization of highway transport, and establishment of economic distribution from producer to consumer.

American highway traffic legislation: National, state, county, township and municipal laws, licenses, taxes and traffic regulations, especially those covering speeds, weights and dimensions of motor trucks, trailers and motor busses.

Fundamentals of highway engineering affecting economic highway transport including: Administration of highway departments; highway systems; location, drainage, foundations, grades, curves, width and shoulders of highways; characteristics of different kinds of roadway with particular reference to traction; snow removal; guard rails, culverts and bridges; highway signs.

American highway transport methods: Comparison of horse and motor transport, municipal haulage, municipal delivery systems, store door delivery, inter-city haulage, long and short haulage outside of cities, rural motor express, return loads bureaus, motor truck parcel post, plant and factory haulage, army transport methods, horse transportation methods. Efficient methods of packing, handling, loading and unloading raw and manufactured materials. Highway transport management. Fundamentals of cost of highway transport. Cost and record systems. Organization of motor haulage companies. Labor for highway transport.

Motor truck, motor-bus, tractor and trailer mechanism, operation, inspection, maintenance, repairs and cost data. Adaptability of different types of trucks and bodies. Disadvantages of overloading and overspeeding. Economic utilization of tractors and trailers. Garages: Accessories, such as tires, fuels, lubricants and mechanical devices.

Transportation surveys, being investigations of highway routes, highway transport legislation, traffic regulations, rural and urban transportation opportunities, competing carriers including railway, waterway and other highway transport facilities, and all other factors which may affect the transportation business which it is intended to establish.

Operating Cost of Truck and Trailer

For several years the Kern County Land Co. has been employing trucks and trailers for handling wheat from its 20,000 acre field to Bakersfield, Calif., 20 miles away. The sacked wheat is carried from the field in mule drawn wagons and piled beside the road. It is then lifted into the trucks by an automatic loader. The company employs eight 3-ton trucks with 3-ton trailers. The trucks carry an average load of from 5 to 5½ tons and the trailers from 5½ to 6 tons. The following figures from The Commercial Vehicle show the operating cost for one of the 3-ton Packard trucks and 3-ton 4-wheel trailer for an 18 month period:

Gasoline	$ 827
Oil	368
Repairs	1,132
Tires	159
Driver	2,241
Total	$5,028
Total miles	22,454
Tons hauled	7,102½
Ton miles	93,337

The average operating cost per mile was 22.4 ct. and the average operating cost per ton mile was 5.39 ct. The above figures do not include the cost of garaging, insurance, interest on investment, depreciation, overhead, taxes and licenses. It also should be noted that the 3-ton truck when fully loaded carried from 5 to 5½ tons and that the four-wheeled trailer carried 5½ to 6 tons. It should also be borne in mind that automotive bucket type elevators were employed to load the sacks of wheat from the ground onto the truck body. The use of this labor-saving equipment naturally permitted the trucks to be loaded more quickly than would have been the case were they loaded entirely by hand. The good condition of the California roads in the vicinity of Bakersfield and to the company's warehouse 18 to 20 miles away also have an important bearing on the cost figures.

With all of these conditions in mind it is interesting to note that the trucks averaged approximately 1,247 miles a month and handled on the average 395 tons a month. For a 26-working day month, this gives an average of 15 tons moved daily, the main proportion of which was sacked wheat carried from the field to the company's warehouse. Except when fuel and other supplies used in the field were carried the trucks ran back to the fields empty.

Cost of Road Surveys and Plans.—During the period Oct. 1, 1916, to Sept. 30, 1918, the State Road Department of Florida made surveys, plans, specifications and approximate estimates for 66 road improvements, aggregating 803.7 miles. The cost was $9,475, or $11.79 per mile.

Trucks and Trailers in City Hauling

By using trucks and trailers, a Boston haulage firm in three years has tripled the tonnage handled by it. This firm, Youlden, Smith & Hopkins, established its business with two horses and a capital of about $500 in 1891. The company was headed by men who were progressive and who worked hard to secure the best customers in the city. These customers were secured by personal solicitation and by advertising in the daily newspapers. After securing this class of business, the company was able to retain it by doing its utmost to please and to give the service desired, the outcome of which was the customer continued to deal with the company exclusively.

In addition to operating the business on such a basis, the company always made it a point to see to it that its activities grew as rapidly as those of its customers. That is, as the business of the customer increased, the team owner purchased new equipment and saw to it that it always had adequate facilities to handle the additional business. In other words, the teamster grew with his customers.

Truck and Trailer Outfit of Youlden, Smith & Hopkins Co.

The business of the Youlden, Smith & Hopkins Co., increased until in 1916 it handled approximately 500 tons of freight daily within a radius of 10 miles from the main office, an activity which required 150 horses and between 45 and 75 drivers.

It was about this time that the motor truck began to be recognized as an economic means of transportation. The company saw an enormous field for expansion if it was able to give its customers a quicker and better service, and if it was able to haul goods to the suburbs of Boston or within a radius of 30 miles. Not being able to do this with horses, the company at first purchased two 5-ton trucks, these being placed in the service of handling goods within a radius of 30 miles, leaving the shorter hauls for horses.

Not only was a large amount of business secured, but the local activities of the company were also increased to such an extent that new equipment had to be purchased. In doing this, every truck purchased replaced four horses, besides increasing both the local and interurban activities.

The trailers purchased were the first to be used in Boston, and although many of the officials of the various communities near Boston were against the use of such vehicles, up to the present time it has been possible to defeat any bill brought before the legislature prohibiting the use of trailers in these communities.

The business of the company has increased in such proportion that it now handles approximately 1,000 tons of freight daily during the busy season. While a part of this may be credited to the advertising in the daily newspapers, etc., it would have been impossible for the company to handle goods within a 30-mile radius with the horse. The company employed a system of laying aside a portion of its income each month which is used in advertising in the newspapers, circularizing, etc. During the past year approximately $5,000 was spent in this way.

The equipment now operated by this teaming company is 15 trucks, [illegible] trailers and [illegible] horses, the latter being used exclusively for local work. All of the trucks with the exception of two, are of 5-ton capacity, while the two smaller units are of the 2-ton type. The 5-tonners are Macks, Pierce-Arrows and Packards, while the 5-ton trailers are of the Troy manufacture. In addition to handling general merchandise, the company does the greater part of the heavy haulage work in that city and vicinity.

The company operates two large offices in the city, and one stable in South and another in East Boston. In addition to this, it has a large stable in Somerville, the total of the three stables having a capacity of 140 horses. It also operates its own fireproof garage, having a floor space of 24,000 sq. ft., with a capacity of 50 trucks. The rates charged by the company for suburban hauling are computed between those of the freight and express rates. Even though these rates are lower than those of the express companies, a regular express service is given at all times.

Salary Schedule for Road and Municipal Engineers

The Chicago Chapter of the American Association of Engineers has adopted a schedule of salaries for various engineering positions. The schedule has been referred to the parent organization with the suggestion that it be utilized for a further study with a view to formulating a general schedule of salaries. The salaries recommended by the Chicago Chapter for road and municipal engineers are as follows:

ROAD ENGINEERS

[illegible]		
Chief highway engineer	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
Bridge engineer	[illegible]	[illegible]
Engineer of tests	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
Assistant engineer	[illegible]	[illegible]
Resident engineer	[illegible]	[illegible]
Chief designing engineer	[illegible]	[illegible]
Designing engineer	[illegible]	[illegible]
Junior engineer Class A	[illegible]	[illegible]
Junior engineer Class B	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

MUNICIPAL ENGINEERS

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible] engineer	[illegible]	[illegible]
Division engineer	[illegible]	[illegible]
Assistant engineer	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
Designing engineer (technical graduate, 10 years' experience)	4,000-	6,000
Designer (technical graduate, 5 years' experience)	3,300-	4,100
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible] architecture	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

New Road Work Records Made in April.—During April, 1919, the Secretary of Agriculture approved project statements for 120 Federal aid projects, involving the improvement of 923.53 miles of road at a total estimated cost of $16,261,326, and on which Federal aid in the amount of $7,528,550 was requested. This represents the largest number of project statements approved, the largest total estimated cost, and the greatest amount of Federal aid requested during any month since the passage of the Federal Aid Road Act. March, 1919, had surpassed all records in these items [illegible] month. During April [illegible] the Secretary and the [illegible] 55 project agreements involving the improvement of 521.51 miles of road at a total estimated cost of $4,626,415, and on [illegible] Federal aid [illegible] in the treasury. In addition, agreements to cover 72 other projects were placed in process of execution during the month. Up to and including April 30, 1919, project statements [illegible] deducting all approved projects cancelled or withdrawn [illegible] 10,580.17 miles of road, a total estimated cost of $92,933,121, [illegible] a total of 535 project agreements had been executed, involving 4,624.83 miles of road, a total estimated cost of $3[illegible]59,327, and a total of $15,614,929 Federal aid.

The Organization of a Standard Municipal Testing Laboratory*

BY F. O. PRESTON

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A standard testing laboratory should be owned by every progressive municipality. The cost of the protection furnished by it over public purchases and the saving through the prevention of losses by overcoming many irregularities of usage is cheap insurance.

The problem of obtaining the best materials for use in public works is a big one. Rapid progress in the manufacture of materials and the frequency with which substitutes are coming to be offered for acknowledged standards, makes laboratory control over the purchase and use of such materials especially important. First class materials can be procured and their proper use can be ensured in no other way.

Proper standards aid in reducing the cost of work, especially those standards of materials and workmanship which can be maintained only with the aid of the laboratory. Not only should the materials purchased shade the minimum standards set up by specifications but preference should be given to the best of those offered.

Testing has been considered only as a science to be occasionally used to determine the ability of a material to meet standard requirements. Rarely has it been utilized as a regular function to determine relative quality. Less often has it been the practice to utilize the knowledge of trained technicians on the laboratory staff to aid in obtaining the best usage from the materials after their purchase

As usual government has been slower than industry to acknowledge the economies which follow the scientific purchasing and use of materials. Laboratories have been developed by the Federal government, by various states, and even by a few of our more enterprising cities. But the cases where the majority of the possibilities of a laboratory have been developed are negligible.

Duties and Functions of the Municipal Testing Laboratory.—The essential duties of a properly operated testing laboratory for any city are:

1. To develop uniform standards.
2. To establish a fair basis for the purchase of materials,
3. To obtain proper qualities in materials purchased,
4. To insure the proper usage of materials,
5. To reduce risk costs to both the contractor and the city.
6. To aid in the advancement of knowledge of materials.

Any municipal testing laboratory that fails to completely fulfill these duties neglects its useful field.

Clean cut competition, based on the contractor's ability to furnish the best of those materials desired can be obtained only by the use of clearly defined standards as set forth in the specifications and in their uniform and continuous enforcement by the testing laboratory.

Many modern standards for materials have been developed by practical field experience and by laboratory analysis and research. Many of these standards have been set forth in the publications of our national technical societies. The consistent use of these, and other standards that should be developed by the local laboratory, establishes a fair basis for purchasing materials and reduces the risk cost to both the contractor and the city.

The laboratory's responsibility does not cease after it has determined which contractor has offered satisfactory materials. Able contractors realize the necessity for standards and not only willingly abide by the specifications but prefer to do so. Less scrupulous contractors, however, resent being held to the letter of the specifications and frequently find some way to deviate from them. So it is evident that picking the lowest bidder, with the aid of the careful comparison of the values offered, does not end the laboratory's responsibility. It must insist that contractors honestly furnish the same standards of materials as they proposed with their bids. If this is not done the less scrupulous contractors readily can underbid their competitors and yet make large profits. If the laboratory does not prevent this, the able contractor is compelled to make similar substitutions or else fail to be able to bid low enough to obtain contracts. The municipality does not get what it pays for when such conditions exist.

Furnishing staff advice to the various municipal departments and bureau heads on problems of specifications, etc., is another laboratory duty which properly cannot be disregarded.

The degree to which the laboratory fulfills its duties is reflected in the service and life not only of the materials, but in the public work in which they are incorporated. Excessive maintenance is necessitated if the materials are not of the proper grade so that materials which had a relatively cheap first cost ultimately become unduly expensive.

Fields of Service of the Laboratory.—The fields of service of the municipal testing laboratory are practically limitless. The first question that should be asked before entering any one field of service, or before expanding existing branches of service, is "What is the importance of this field relative to the others?"

The municipal laboratory usually originates in the engineering (or public works) departments because of the technical nature of the work done there. For this work the laboratory should not only do routine testing but should investigate local sources of materials such as sand pits, stone quarries, etc. But the laboratory should expand from a purely construction or engineering laboratory into the city's standard laboratory and be under the supervision of the Board of Control and Supply for the city. It should serve, not only the engineering field, but also the city's fire, police, water, purchasing, and other bureaus, shops, garages and utilities. For example, it should determine the relative value of the city's fuel, foods, materials of building construction, rubber for fire hose and firemen's boots, etc.; etc.

Until the laboratory can be organized and equipped as a "Standard Laboratory" to handle the testing that is warranted by the entire field of municipal activities, the scope of the work will be mostly engineering testing. The question naturally aroused is how will the men be usefully employed during the winter months. If the letting of contracts is planned in advance, then many samples of materials will be received with bids for work during the early spring of the year. Investigations of materials and specification remodeling would fill in the partly vacant time freed by the curtailment of the work in the late fall. In the beginning, the mid-winter testing may be confined to sewer work, for example, and the remaining time could not be more profitably applied than if used for research work. An example of this possibility is the determination of the applicability of magnetic testing of iron and steel. Determining the practicability of ideas received from the field and arising in the laboratory during the busiest times of the construction season is another item of work properly belonging to the winter season.

As the volume of testing increases and the scope of the laboratory expands, occasional special studies will warrant even more highly specialized apparatus than is needed for routine testing. In order that such special work may receive accurate analysis, and, at the same time, that the investment in special equipment be made economical, it is recommended that the laboratory do some local commercial testing.*

The laboratory then not only would serve all of the city departments but aid local industry. This would materially facilitate civic business, procure better materials for citizens, and would bring revenue to the city. The more frequent use of special apparatus would make its purchase economical. Experiments then could be performed that ordinarily would not be made because of the lack of facilities. The extra money and work to be done would be provided, thereby enabling the employment of highly specialized scientists in many branches of the work. In performing this function it is essential to keep all interests secondary to the official city requests, giving each class of work the relative attention that it deserves.

Development of Personnel of the Laboratory.—The successful operation of any enterprise depends upon the personnel responsible for it. This is especially true of a testing laboratory. No matter what plans are adopted, they will be fruitless unless energetically carried into effect. Moreover, efficient growth depends upon the initiative and earnest effort of the laboratory personnel to cover its useful field.

Naturally a capable and experienced director is very important. He should be given money and authority to gradually build up a modern testing laboratory that will properly safeguard the city's interest. If he is qualified to determine the relative value of expenditures and purchases for the city, he is fit to be trusted with an expense account ample enough to enable him adequately to cope with the ever-changing conditions in his work. The director should not be restricted by any influences except limitations similar to those placed upon a thoroughly business-like, energetic manager of an industrial enterprise. This is no more than fair to the taxpayers, whose public purchases he would endeavor to safeguard, improve and cheapen. The testing laboratory, rightfully considered, is a municipal business enterprise in which the taxpayers are the stockholders. The laboratory director is the manager of the enterprise by right of his special knowledge and experience. Not only money, but authority to spend it must be allowed him. Dividends in the form of decisions as to the best materials are the economic products.

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*In some cities a charter change or some form of state legislation is necessary to give the authority to do this.

On the staff of the laboratory, in addition to the director, should be specialists in the various branches of science used in the testing of materials. For example, a chemist is needed to attend to the testing and aiding in the proper usage of bituminous materials, to analyze gas, water, coal, sewage, gasoline, rubber, explosives, etc. A civil engineer is required to test paving, building, and other construction materials. An electrical engineer is needed to test and experiment with the street lighting system, etc. A mechanical engineer will be needed to take care of tests on such things as structural materials and machinery, when the volume of such work increases enough to unbalance the regular duties of the civil and electrical engineers. Later, when the laboratory expands to include the bureaus of health and public safety, a specialist in sanitary chemistry will be needed to test foods of a special nature or over which there is a controversy and to assist the police bureau to solve poison cases and other such problems. The textile expert should determine the paper and binding best for use in school boks, etc.

One of these specialists should be designated as the principal assistant to the director and instructed to assume charge of affairs during the latter's absence. It is not necessary that this man be the one receiving the highest salary or having been employed longest; ability should be the determining factor.

Another addition to personnel that as yet has not been considered by laboratories in general, is a corps of inspectors for collecting samples. The laboratory should not wait for samples to be sent in for tests but should arrange for their systematic collection. This calls for the development of an organization to collect them. Usually it has been the custom for field inspectors assigned to the particular job to collect the samples from it and, by various means, to send them to the laboratory. This not only leaves the collection of samples to chance, but just as experience has proved the inadvisability of leaving to the field inspectors the determination of quality of materials, so it is true that field inspectors seldom are qualified to select samples for varying grades of materials. The only safe and sure procedure is to have trained laboratory men go into the field and collect all samples. This is in direct opposition to the now obsolete theory governing the policy of many laboratories: that the tester should know as little as possible of the source and identity of the samples.

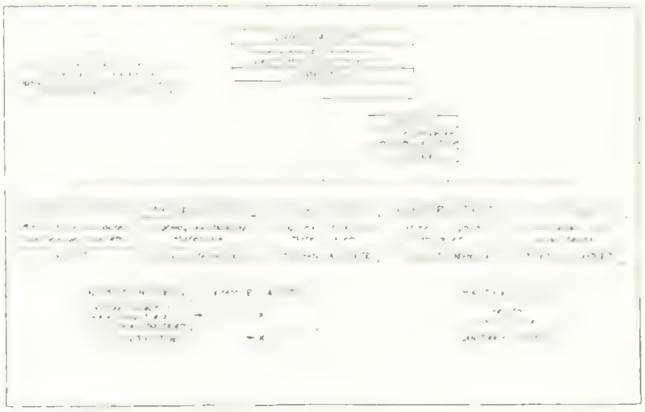
The inspection (or sample collection) corps should be headed by a chief inspector who should see that the work of each of the laboratory specialists receives the relative attention due it. Besides collecting samples it should be the duty of the collection organization to keep laboratory records of contracts advertised by the city, bids and materials received, contracts awarded, work about to be begun, construction in progress (by the use of a graphic progress chart, etc.), and jobs completed. This would be an invaluable aid in planning the laboratory work.

The collection organization is of great value in other respects. By its use laboratory control of materials is more complete, and field inspectors can be instructed in the proper use of materials. Certain of the inspectors should be stationed at asphalt plants when in operation, also at local plants of local manufacturers of brick, tile, etc., thereby ensuring better plant control and also aiding the laboratory in checking or rather inspecting the output of such plants. Moreover, complaints arising from the field or from property owners as to the character of materials and workmanship, can readily be investigated by the laboratory inspectors, independently of the regular field inspectors.

Incentive for field inspectors and, at the same time, which is very important, a nucleus for a future laboratory staff, will result if the laboratory inspection (or sample collection) corps is selected by merit, whenever possible, from the best qualified men in the construction (or field inspection) corps. Such men, if they have the necessary professional qualifications, become fitted for the laboratory inspection corps because of their experience and training by the present laboratory inspectors in the use of materials. Also they frequently merit further promotion to regular staff positions in the laboratory. Laboratory inspectors who do not have the essential professional qualifications, can be transferred when conditions warrant it to some other branch of the technical service, such as the Engineering Department, or the Department of Public Works, etc.

Because of the usual increase of work for the collection corps during the summer construction season, it is good policy to employ a few students from advanced technical schools during their summer vacation, to aid in the gathering and routine testing of samples.

A stenographic clerk is needed in the laboratory in order that clerical work may not consume time properly applied to scientific work; for the experts should not stop their important duties to typewrite records, reports, letters, etc.



Staff Organization for Standard Municipal Testing Laboratory.

Civil service is necessary to ensure a stable organization for the laboratory. Clearly defined requirements for staff positions should be set up, and provision made for advancement both in salary and position as a reward for meritorious service. This is the only way in which capable and energetic men can be attracted, on the one hand, and in which political interference can be prevented on the other. Tentative requirements for a few of the various positions in the laboratory staff are suggested as follows:

The laboratory director should be at least 30 years of age; he should be a chemist or civil engineer, having graduated with a degree from a college of recognized standing; and should have at least five years' experience in testing and using the majority of the materials cared for by the laboratory. He should have the demonstrated ability to plan and to direct the work of men.

The chemist should hold a degree from a college of recognized standing, and he should have at least two years' experience in the standard methods of testing and using such materials as bituminous paving materials, water for municipal consumption, gas, coal, sewage, rubber, explosives, gasoline, etc.

The qualifications for the other men should be [illegible] along these lines. The specifications and requirements set up for positions in the Central Testing Laboratory of New York City offer a good basis for further development, but they are not thought to be complete in many respects.

The organization above outlined is graphically represented in Fig. 1. The number and type of specialists mentioned are not necessarily all of those needed; those mentioned are the ones generally required for engineering work but do not include the men needed to attend to textiles, etc., as will be required as the laboratory expands to more [illegible] proper field.

Arrangement of Laboratory.—The size and number of rooms required for laboratory purposes is a matter which must be determined differently for each case. In some cases the laboratory may be started in a pair of four rooms in the basement of some public building. But in any event it should be kept in mind that as the work has developed to fully care for its proper field, the laboratory will require not only several rooms but several floors of a building.

A basis for determining the number of rooms and their arrangement is given by the following items: the entrance into the laboratory should be through or by way of the office. This will prevent visitors from walking promiscuously through the laboratory and interrupting work. Sometimes the objection has been raised that by having the entrance near the office it is impossible to keep the room clean, because of the frequency with which bulky and dirty samples are brought into the laboratory; for this reason it is best to have a side door or hallway entrance opening into an alleyway, so that samples may be taken in by it, and thus not dirty the office. However, the objection is minor and should not prevent the office from being the entrance room.

The office should contain desk room for each man; a large table to be used for computing data; a folding drawing table; plenty of space for record files; cabinets for delicate apparatus and book cases.

A special room is needed to contain apparatus and chemicals for testing bituminous materials, etc. Such a room should be amply provided with gas hoods and ventilating fans. It is also very good practice to have a gastight enclosed shelf in the center of the chemical testing room in which should be kept all bunsen burners and other apparatus which may ignite inflammable gases. This shelf should be enclosed with glass windows which can be opened to allow the entrance and removal of materials as needed; it should have several connections for water and gas and should be covered with a water and fire proof material (such as galvanized tin); and should be ventilated at the top by means of electric fans opening to the free atmosphere. The centrifugal machines used for washing bituminous mixtures should be located at some distance from this enclosed shelf in order to prevent carbon-disulphide vapors from reaching the bunsen burners.

Another room should be allotted for use in testing sand, cement and concrete. It should contain storage racks and ovens for briquettes, cubes, etc. Another room may be needed for electric testing and will require electrical meters, switchboards, transformers, lamp racks and motor connections.

The brick testing rattler machine, the Deval stone machine and the coal testing apparatus are best located in the cellar, as should be all other large and heavy crushing and grinding machines also.

A stock room is essential to contain a good supply of chemicals and other needed materials required over a given period.

Unless the laboratory is very large, it is not thought economical to equip a room as a machine or carpenter shop, because ordinarily the tools needed for minor repairs to apparatus can be obtained from the municipal shops.

Equipment of Laboratory.—Most of the testing procedures have been standardized enough to warrant the manufacture of standard apparatus and testing equipment to replace the "make-shift equipment, which was formerly customarily prepared in laboratories. Standard apparatus saves time and enables the tester to obtain more accurate results; and by its use the "personal factor" is largely eliminated and data and results obtained are more easily duplicated. Considerable apparatus is necessary to perform standard tests by standard methods and in order that its purchase may be economically made, it is suggested that it be purchased in installments of comparatively small lots. Once the laboratory becomes properly equipped, it should be kept so by a system, whereby a definite quantity of apparatus is obtained each year.

Apparatus that has become obsolete due to improvements in methods of testing, etc., should not crowd and overburden the laboratory, under the excuse that it may "come in handy." Apparatus out of repair should be put into workable condition at the earliest possible moment, in order that tests may not be delayed. Improper care of equipment will result in rapid deterioration; delicate apparatus should be kept in specially designed cases. Some of the spare time of the laboratory men should be utilized to inspect the apparatus periodically.

A library should be considered properly as part of the equipment of a testing laboratory. The most important working tool to any professional man is a complete reference library. It is important that a scientific man develop methods and understand principles and laws; but the details and data attached to them should not clog his brain; thereby hindering clear thinking. He should be familiar with the details, however, and should know where to find them, and have books containing them readily accessible.

The library should be kept up-to-date with the latest editions of technical books of a wide range of subjects. It should be the object to collect books containing specific data. Books of a general nature need not be had in the laboratory, but it is advisable to have a list of such books that may be found in the local libraries.

Technical magazines are an important item in the library. The laboratory director should make it his duty to obtain and study all information published in the leading technical journals and the men should be required to devote a specific amount of their time in following their fields as covered by certain of the magazines. The magazines should be referenced and bound for the future use of the laboratory specialists.

System in the Laboratory. The regularity and promptness of testing is another factor affecting the success of laboratory operation. System is required to insure the daily performance of duties, to make sufficient plans to properly balance duties and to give to any one item the attention which its relative importance warrants. It is necessary, in order to plan for work in advance, that charts and information of the nature suggested when the laboratory's corps of inspectors was discussed, be utilized. The laboratory should make daily itemized work schedules by the use of the work plans; by insisting that contractors give ample notice before beginning various phases of work; from report cards sent in by the field inspectors, or by written reports of the field engineers and city purchasing agents; and by other means of co-operation. These schedules should be rigidly adhered to, and only deviated from by force of dire emergency.

Without a work schedule, or with one that is but partially enforced, the writer has observed that samples frequently were not collected in time or that test results were obtained too late for use, or were so late as to materially delay and interfere with the work schedule of the contractors. Furthermore, but a limited amount of work could be handled and even that amount was hastily and incompletely performed. What happened was simply that the multiplication of duties was allowed to become a complication.

The work schedule should be checked by records of work done from day to day, thereby giving data on which to base plans and from which to prepare a yearly budget and other tabulated information essential to the development of the laboratory.

Records of all tests made by the laboratory during the past five years should be referenced on file. Law suits which have developed from disputes by contractors have been settled by such reliable facts.

Status of New York State Road Work in 1918.—New York State highway contracts aggregating 363 miles of road were completed in 1918. The status of this work on June 1, 1919, is outlined as follows in the last annual report of H. E. Breed, First Deputy Highway Commissioner:

	Miles.	Miles.
On Jan. 1, 1918, there were contracts in force aggregating	.....	1,111
Contracts awarded during 1918	.....	000
Total under contract during 1918	.....	1,111
Contracts completed and accepted during 1918	269	
Contracts completed during 1918 but not in time for acceptance	94	363
Leaving under contract Jan. 1, 1919	.....	748
On contracts in force Jan. 1, 1919, aggregating 748 miles of road work has been performed as follows		748
Prior to Jan. 1, 1918	[illegible]	
During 1918	41	[illegible]
Leaving on Jan. 1, 1919, actual work to be performed under contracts in force		[illegible]

Nebraska Highway Department Publishes Magazine.—For the purpose of furnishing county officials and others interested in road improvement with a complete financial status of appropriations and expenditures, together with other material relative to the progress of road building in the state, the Nebraska Board of Irrigation, Highways and Drainage is now issuing a Monthly Highway Report. The first issue of the magazine appeared on May 1. It is edited by Geo. E. Johnson, Secretary of the Board.

Road Surfacing with Sand Clay from Salt Flats

Difficulty in obtaining mudshell for surfacing roads in Aransas County, Texas, led to a trial of a sand clay material from salt flats adjacent to the highways. The method of using this material and the results obtained are described by Mr. Richard H. Phillips, Engineer of Aransas County, in Public Roads, to which we are indebted for the matter that follows:

The deposits of sand clay in salt flats vary in composition, but for use in road making enough silt or earthy matter must be present to form a film or coating to the grains of fine sand, so that when drained of excess moisture and compacted under traffic it will form a uniform wearing surface. It develops that this material is primarily a mixture of Epsom salts and gypsum, with some impurities.

The deposits drawn from are located in what are known as salt flats, distant anywhere from 100 to 3,000 ft. from low water at the bay shore. Some seasons these flats are covered 4 to 6 months of each year with salt water, but most of them from which road material is obtained are covered for only 2 to 3½ months of each year. In the spring when these flats are becoming dry the salt crystallizing on the weeds and lowest points becomes quite noticeable. Local rains cover the lowest points with water and tend to dilute the salt content, but the surface of these flats soon becomes dry through evaporation. In some deposits the earthy content is a black silt, some dark brown, and other deposits are of a light yellowish brown. While designated as sand clay from salt flats, the sand, as can be gathered from the above description, largely predominates.

There is an excess of moisture in most deposits, which generally drains out while being hauled to the road, leaving the mass in a suitable condition for spreading. This material, evenly spread, readily compacts under traffic. Any depressions that appear are filled with shovels or by use of a blade machine or a three-blade drag.

When properly surfaced the top of the road is somewhat like a sheet asphalt surface in dry weather.

It becomes slippery in wet weather, and for that reason the crown should be made slight (not to exceed ½ in. to 1 ft.). If the proper attention is paid to maintenance and repair a slope of ¼ in. to 1 ft. will be sufficient.

Wide Roadway Necessary for Best Results with Sand Clay Surface.—The roads on which sand clay has been used were surfaced in varying widths, 10, 12, 14 ft. and a small amount of 16 ft., none of which were wide enough.

Vehicles, in passing, even on 16-ft. widths generally have their outside wheels off the improved surface, especially where the crown is steep. In such cases the wheels, in getting back on to crowned surface, break through the edges. This being frequently repeated, soon renders the entire road unfit for heavy hauling and makes exceedingly rough going for auto traffic, either light or heavy.

To obviate this condition all roads in Aransas County designated as state highways and on which sand clay surfacing is to be used are laid out 24 ft. wide with shoulders not less than 2 ft. wide to be solidly rolled to same slope as the sand clay surfacing.

With this width of traveled roadway the wear of the surface is comparatively uniform and more easily maintained in good condition.

The data covering the use of sand clay in Aransas County can be somewhat summarized as follows:

Width of original surfacing varied from 10 to 16 ft.

Thickness of original surfacing varied from 3 to 6 in.

Foundation for surfacing: Some places used old traveled way (sandy loam), at other points graded with slips or fresnos and dragged without rolling, at other points the surfacing material dumped on the swamp or prairie grass after the side ditches had drained the roadbed, the grass in the latter case providing a better foundation than where the roadway was newly graded.

The material was dumped without being evenly spread with the result that ruts and humps were numerous; some stretches were surfaced with material with scarcely any clay or salt content. Such stretches rapidly approached the condition that exists where deep loose sand is encountered.

Layout of Improved Roads.—The roadway for in- [illegible] highway No. 12 (Jefferson Davis Memorial Highway) between Aransas Pass and Rockport, has been laid out as follows:

Width of surfacing 24 ft., shoulders not less than 2 ft. between culverts, curbs 12 ft.

Slope of [illegible]

The old [illegible] road [illegible] the additional width of subgrade is brought up to the level of that of the old road. It is found that the moist sand clay will form a close bond to even the most solidly compacted surface; hence, when the new surface material has been used on undisturbed portions of the old road, the latter is found to provide a foundation of the very best.

Generally the new surface [illegible] in. thick, but at some points where there is already an unbroken thickness of sand clay only enough is added to bring the top to uniform grade.

In some sections there are a few stations where the grade of old road has to be brought up to established grade with material from the side.

Surfacing material consists of selected sand from salt clay adjacent to the road, the haul varying from ¼ to 2 mile.

In some deposits there is from 1 to 6 in. clear sand on top. Generally there is sufficient clay present to admit of the use of 1 in. or more of the clear sand top, but in no case is any material allowed that will not properly compact under traffic or road roller when excess moisture is drained out.

Cost of Surfacing with Sand Clay.—The cost of this surfacing has varied from 25 ct. to 42½ ct. per cubic yard for first ¼-mile haul, including loading and unloading, and from 5 ct. to 7½ ct. per cubic yard for each additional ¼-mile haul.

The spreading costs from 5 ct. to 25 ct. The range of prices is due partly to care with which material was selected, the manner in which it was spread, and also the time when the work was done.

Shipyard construction and other building activities in vicinity of Rockport and Aransas Pass has tended to raise the price of both labor and teams, so that the maximum figures mentioned just about cover the cost at this date. Common labor costs 25 ct. to 35 ct. per hour and teams 55 ct. to 75 ct. per hour.

Material has generally been loaded into wagons by shoveling, but at a number of points the conditions are favorable to use of the Maney 4-wheeled scraper.

Maintenance of Sand Clay Roads.—The salt content in well-selected sand clay from salt flats prevents the surface from becoming unduly dry during the hottest seasons, and over night sufficient moisture is absorbed to enable one to quickly distinguish roadway surfaced with this material from other portions surfaced with material from which the salt content is absent.

Annual [illegible] approximately 73.33 cu. yd. per mile. Add to this amount, say, 50 cu. yd. per mile for filling depressions that develop under traffic and figuring the material at 75 ct. per cubic yard applied, the maintenance cost for surfacing will run [illegible] $100 per [illegible]

When a county is able to provide the equipment, a motor truck of about 2½ yd. capacity provided with a bed having four doors operated separately by the driver and a special type of 3-blade drag will prove to be an economical method of keeping the roadway surface in first-class condition. In addition to this, use a suitable drag or road machine promptly after rains to shape up the shoulders and ditches. An 8-ton roller will be a valuable addition to be used for compacting the shoulders and such portions of the roadway as may need attention from time to time.

The sand clay surfacing is somewhat slippery in wet weather, but it should be noted that the most unsatisfactory condition obtains where the surface has been allowed to become filled with ruts and humps, and the latter along with a slope already excessive present a slope as great as 1 to 2 in. to the foot. If proper maintenance of the surface is observed and no greater slope than ½ in. to the foot is allowed it will be found that but little sliding will occur on a roadway 24 ft. wide, such a width being sufficient for autos to pass at usual speed without having to swerve out of direct line.

Treating Slippery Sections.—Sections which under traffic develop a slippery surface in wet weather will be benefited by using about ½ cu. yd. of fine shell (either partially disintegrated oyster shell of size 1/32 in. to 1 in. or fine shell other than oyster) spread evenly over the surface or use an equal [illegible] sand free from earthy matter.

It should be particularly noted that the life and easy maintenance of a roadway surfaced with sand clay from salt flats are predicated largely on one condition, and that is the treated width should never be less than what is required for vehicles to pass without one or both having to get off the treated surface.

Surface Treatment with Light Road Oil or Heavy Bitumen. The surface treatment of shell or sand clay roads with either light road oil or heavy bitumen is not favored in this locality, and has not proven a success where the surface exposed to wear is composed of sand or shell bound with bitumen.

The best bituminous-treated surface tried in this vicinity on dry shell road consists of a priming coat of about 0.3 gal. refined coal tar (about 1.15 specific gravity), followed with a coat of about 0.45 gal. refined coal tar (about 1.25 specific gravity), both coats applied hot.

The second coat to be followed with a layer of trap rock of size ⅝ in. down with two-thirds of the fines screened out the amount of trap rock to be from 60 to 70 lb. per square yard. Occasional spots of bleeding to be blotted with clean dry sand, but in general the coating of trap rock should be sufficient to prevent the tar from being picked up by wheels in traffic.

The same kind of bituminous trap-rock treatment can be given the sand clay surface after a coating of fine dry shell free from earthy matter has been spread and ground into the sand clay surface by traffic. The sand clay surface without the dry shell will not allow sufficient bond of the bituminous trap-rock treatment.

Average Bidding Prices on New York State Road Work

Bidding prices at April and May lettings of the New York State Commission of Highways ran reasonably close to the engineers' estimates. The following were the average unit bid prices on some of the main items:

	April	May.
Earth excavation, per cu. yd.	$1.05	$1.13
Rock excavation, per cu. yd.	2.36	2.81
[illegible] pipe underdrain, per ft.	.46	.34
[illegible] per sq. yd.	.92	.93
Steel reinforcement, per lb.	.10	.10
Miscellaneous iron and steel, per lb.	.09	.10
Wooden guard railing, per lin. ft.	.17	.19
Pipe railing, per lin. ft.	1.77	....
Concrete sign posts, each	15.52	15.58
Cast iron pipe, per ton	76.00	74.71
Foundation course field or quarry stone, per cu. yd.	3.29	3.65
Bottom course broken stone, per cu. yd.	4.71	4.86
Concrete foundation for pavement, per cu. yd.	10.25	....
Metal reinforcement for pavement, per sq. ft.	.03½	.02½
Cement concrete pavement, per cu. yd.	12.75	12.56
Second class concrete, per cu. yd.	12.87	12.19
Third class concrete, per cu. yd.	11.90	11.35
Bituminous macadam penetration method, per cu. yd.	6.30	6.83
Bituminous material "A" penetration method, per gal.	.16	.127
Bituminous material "T" cold application, per gal.	.23	.17¾
Water bound macadam broken stone, per cu. yd.	6.60	6.62
Bitulithic pavement, per sq. yd.	2.05	....
Brick		2.00

Rock with Crushing Strength of 53,880 Lb.—Deposits of trap rock having a crushing strength of 53,880 lb. per square inch have been located near Austin, Tex. Results of tests of this rock made at the University of Texas are summarized as follows in The Highway Magazine:

Specific gravity	3.21
Weight per cu. ft., lb.	200.6
Per cent of wear	2.9
French coefficient	14
Hardness	19
Toughness	23.5
Cementing value, dry, not slaked	144
Crushing strength, lb. per sq. in. on 1-in. cube	53,880

This rock is located about 7 miles southwest of Austin on an old marine volcano, known as Pilot Knob. There is a very extensive deposit of this rock at that point, but it has not been used as a road material on account of the fact that there is no railroad leading out to it. There are several other lesser deposits of this same material around Austin. The technical geological name for this rock is Nephelite Basalt.

White Bricks Mark "Danger Lines" on Pavement

White enameled brick set in the pavement are employed by the United Railroads of San Francisco for marking the limits of danger zones. This plan is used at the foot of Market Street where the street cars round loops. As the front and rear ends of the cars swing out well beyond the rails on the sharp curves it has been the custom to keep a white stripe painted on the pavement to mark the limit of the danger zone. But as these lines lasted only a few weeks and in fact were at their maximum efficiency as markers only for the first few days because the contrast in color quickly wore off, particularly in wet weather, they were replaced with intermittent rows of white enameled bricks. It is expected, states the Electric Railway Journal, that marking by bricks will be cheaper in the long run than the use of paint.

"Danger Lines" Marked in Pavement With White Brick.

Holes were cut in the asphalt a trifle larger than the bricks which were then grouted in with neat cement. The use of a dotted line was considered more striking to the eye than a continuous line would have been. About 330 bricks were used for all three loops. These bricks, which cost $110 per thousand, would not be suitable under vehicular traffic, but are expected to give satisfactory service at this point where nothing but pedestrian traffic crosses the pavement.

The words "Danger, Keep Off" were put in two places just inside the white brick line, set flush with the pavement surface. The letters were made 12 in. square and were cast at the company's shops, the facing material being marble dust and white cement. The letters are 2 in. thick, of which only the upper half is the white composition, the remainder being common concrete reinforced with No. 12 galvanized wire. The letters were cast face down, the marble compound being put into the forms first and on this a solid concrete base 12 in. square was cast on all letters alike.

When the letters had to be put in basalt-block pavement a section of the blocks was removed and the letters were set in asphalt. Asphalt was filled in the inclosed parts of the letters before they left the casting yard. The bricks and letters were laid by the street repair crew without difficulty, the work being done under the direction of B. P. Legare, engineer maintenance of way, United Railroads.

Status of Federal Aid Road Projects.—Up to May of this year, 1,057 project statements for Federal aid roads had been approved by the Secretary of Agriculture. They involve the improvement of 10,580 miles of roads at an estimated cost of $92,933,121, of which the Federal aid requested was $36,576,857. The amount of Federal funds available on March 1 for road building was more than $72,900,000, which, under the law, must be matched by an equal amount from the states, making a total of $145,800,000, which includes approximately $9,800,000 from Federal and state sources for roads in the National Forests. Funds that will become available on July 1 with equal contributions from the states, will provide an additional $198,000,000 for Federal aid road work, making an aggregate sum of $343,800,000 available for the calendar year. It is expected, however, that the states will defer taking up part of the available funds until 1920.

Items Which Must Be Considered in Calculating Cost of Truck Operation*

Motor truck costs are a delusion and a snare unless they are properly applied and the conditions under which they were secured are fully considered. From the present or prospective truck owners' viewpoint truck cost figures are of value from three angles, as follows:

1. To determine upon the rates to be charged when the truck is used in public haulage.
2. To estimate the cost of truck haulage as compared with other methods of shipment.
3. To compare the costs of operation of one truck with that of another of the same capacity, in the same class of work, in the same city, or to determine if the cost of any one item of truck expense is excessive.

Comparing Truck Cost Figures with Rail Rates. In order to determine the comparative cost of truck haulage with railway or waterway transportation, in which the rates are generally given in so much per hundred pounds between any two points, it is of course necessary to calculate the cost of highway transportation on the same basis. In this connection it should always be borne in mind that whereas the railway and waterway rates are from terminal to terminal, the truck delivery is generally direct from the plant or place of business of the consignor to that of the consignee.

In any comparison of truck cost figures with rail or waterway haulage, the total cost of moving the goods from the point of origin to the point of delivery should be the basis taken when the motor trucks deliver direct from the shipper to the consumer. This is necessary because by the railway or waterway method of shipping there are many items which must be charged and which yet do not appear in the freight rate between the two points. These additional items include teaming charges at each end of the route; the extra costs of crating or boxing not generally necessary when goods are shipped by truck and the increased weight of the shipments by rail due to the weight of the crating or boxing on which the same rate per hundred pounds must be paid as for the goods themselves.

Cost Keeping.—Most owners believe that the peculiar conditions of their own particular business require some special form for keeping their truck costs. This is not the case, for the items entering into truck cost are well known and only few in number.

Truck costs may first of all be divided into two main heads, as follows:

1. The actual charges against the truck operation, including operating charges, maintenance charges and fixed charges.
2. All overhead items which are necessary in order that the trucks be operated as a means of performing work by actually moving goods.

It is very important that these two classes of charges be kept separately in order that the mechanical or operating efficiency of the truck be determined and leaks in that regard be stopped. Then, too, the actual operating, maintenance and fixed charges are of practically the same nature for any size or make of truck, whereas the overhead charges vary greatly according to the class of work in which the trucks are engaged. Because of this great variation, these overhead items should be charged separately. They should not be lost sight of entirely by any means, as has often been the case when a truck owner forgot to charge overhead, supervision and provision for idle truck time or part-load work.

The actual charges against the truck operation may be divided under three heads, including operating charges, maintenance charges and fixed charges. Under the heading of maintenance charges may be placed the items of gasoline, oil, grease, kerosene, driver, helper and mechanic. Under maintenance charges may be placed the cost of tires at so much per mile according to the guaranteed life; repairs, overhauling, painting, etc.; spare vehicle rental and a pro rata charge for garaging. Under fixed charges may be placed items for all forms of insurance, including fire, liability and collision, on the truck itself and insurance on the goods carried, interest on the investment at 6 per cent or other legal rate of interest; depreciation on chassis, body and equipment, and total taxes and licenses. These items must be charged against the actual truck operation and hold true no matter what size or make of truck is employed nor what manner of work it is engaged in.

The average yearly cost of operation of a motor truck, including the items just given, is sometimes equal to if not greater than the original cost of the truck chassis, body and other equipment. It is very important for the truck owner to know the relative importance of the various items under the three heads of operating, maintenance and fixed charges. It is easy to visualize these various charges and their importance in the yearly cost of operation by thinking of them as the Big 8 in truck operation. These Big 8 items and their order of importance are generally as follows.

1. Driver.
2. Tires.
3. Gasoline.
4. Overhauling.
5. Depreciation.
6. Insurance.
7. Interest.
8. Garage.

Only two principal forms are necessary to keep these various items of actual truck operation included under the heads of operating, maintenance and fixed charges. One of these forms must be a driver's daily route card, on which he will put down the work accomplished during the day. This should include the number of trips made; the number of tons or packages hauled in and out; the mileage per trip; the amount of gasoline, oil, grease, kerosene and waste used; a notation for a helper, if employed, and for a mechanic if any work was done on the truck outside of the time usually set aside for it.

The information set down on the driver's [illegible] card must be secured day by day and kept separately for each truck. At the end of the month it may be transferred to a monthly sheet, the various items being set down under the heads of operating, maintenance and fixed charges.

After all these data for a month's operation have been gathered together, the reverse side of the monthly or yearly form may be employed for estimating the unit cost of operation on any desired basis. This may well be done by dividing up the data under the heads of Investment, Performance Record, Performance Averages and Recapitulation. Under the head of Recapitulation one may estimate the cost per day maintained; the cost per day operated; the cost per mile operated; the cost per commercial ton-mile, package-mile or stop-mile.

After these cost figures have been [illegible] forms, one must add the overhead charges. For truck owners engaged in public haulage, the final or total operating charge as determined from the monthly or yearly sheet mentioned above should be [illegible] to obtain [illegible] of from 10 to [illegible] capital invested.

Too often the truck owner estimates his monthly or daily cost of operation with a maximum load, only to find that in actual practice his truck is idle 50 or 60 days a year, and, in addition, is only 33 per cent efficient on the days when it is not idle.

[illegible] operating [illegible] for moving goods will be sufficient to take care of idle truck time and all of the other overhead expenses to insure the [illegible] obtaining [illegible] profits on the capital invested. These other necessary items [illegible] office rent and office force, idle truck time, non-capacity loads, the maintenance of warehouses or depots, advertising [illegible] items which must be included when the truck owner sells transportation as a business and has no other source of revenue, as is the case of a wholesaler or retailer who must first sell his goods and then deliver them by means of trucks.

In the latter class of truck owners, the actual operating charges included under the heads of operation, maintenance and fixed expenses are of the same nature as with the trucks doing public hauling, although the overhead charges naturally [illegible] to the class of business considered.

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*[illegible] an address by Joseph [illegible] before the Moto[illegible] [illegible] New Jersey.

Highway Construction in New Jersey to Meet Future Traffic Conditions

An interesting description of what New Jersey is now doing in its State highway system to provide for future traffic requirements was given by Mr. W. G. Thompson, State Highway Engineer, in a paper presented May 14 at the annual meeting of the National Highway Traffic Association. We quote from his paper as follows:

Alignment, Grades and Width.—On all State highways the graded width or carriageway from gutter to gutter will be not less than 30 ft. In the open country we are going to considerable expense to secure curves not sharper than 6°, and grades not exceeding 5 per cent. All curves sharper than 5° are being super-elevated or banked, there being a gradual transition from the straightaway to the curved section. This method has already proven its value as an aid to easy riding since there is no perceptible strain or overturning motion while rounding the curves so treated.

Drainage.—Particular attention is being given to sub-foundation drainage, upon the adequacy of which the integrity of the pavement depends in marked degree. It is believed that expense incurred on this factor, before the pavement is laid, is justified because the pavement may be rebuilt or rejuvenated from time to time without entire removal to correct drainage conditions which should have been cared for during the initial construction. On long flat stretches storm sewers are being built with catch basins to carry off surface water which would not flow in flat grade side ditches or gutters.

Pavements.—Hard pavements will be not less than 18 ft. wide. In addition there will be 3 ft. stone shoulders on each side, making in effect 24 ft. pavements. There will then be 3 ft. earth or gravel shoulders, making a total of 30 ft. of carriage or traveled way. On the main heavily traveled routes are being laid concrete pavements 8 ins. thick at the sides and 10½ ins. thick at the center. On the secondary routes are being laid concrete pavements 6 ins. thick at the sides and 8½ ins. thick at the center. Where asphaltic, brick or stone block pavements are used they will have concrete foundations not less than 6 ins. thick, except that in the more isolated sections, where traffic will not be heavy for many years, asphaltic pavements will be laid on existing macadam bases, where such exist of proper width and depth. None of the State highways will be paved with macadam or bituminous macadam, or any other material inferior to asphalt or concrete.

Why "City Pavements" Are Being Used on Highways.—A sincere effort is being made to build for the highway traffic demands of tomorrow. In alignment, width, grade and pavement, the viewpoint is that we are building for a long time to come and the best obtainable, within reasonable financial limits, should be had now.

In the Engineering News Record for May 8 is found this question, "Why are such revolutionary changes necessary in pavements which have given satisfactory service on heavy traffic city streets heretofore?" It seems to me there are several good reasons for the building of city pavements on interurban and country highways. In the first place, city streets, until the past 3 years, were never subjected to the test to which they are now, and will hereafter be subjected, and it remains to be proven that present city pavements will stand the new strain. We can all remember when no vehicle using New York streets traveled at a greater speed than 4 or 5 miles per hour. Heavy horse-drawn trucks downtown moved 3 or 4 miles per hour. Now, motor trucks with the same and heavier loads travel 15 or 20 miles per hour. On rough pavements the impact and destructive forces are, therefore, now many times greater, notwithstanding the change to solid rubber tires. If these things be true in crowded city streets, will they not be more true on country highways, where, when city restrictions as to speed no longer hold, every class of motor vehicle increases its speed to 25 or 30 miles per hour. I am convinced that if speed alone were to be considered, it will be necessary to build stronger pavements on interurban highways than on city streets, especially in New Jersey, where, because of its many industries, the motor trucking between cities is very heavy today. Tomorrow will but bring a greater volume and density.

The drainage factor also requires that heavier pavement foundations be built on interurban highways. City streets are usually paved from curb to curb. They are underlaid by sewers, pipe lines, conduits, etc., all of which conduce to good sub-foundation drainage, while surface water runs to the gutters and is quickly carried away by the sewers. In the country, and especially in cuts, there are springs, the menace of which it is difficult to remove. Water from open ditches and hillsides seeps into and under the foundation. In wet weather, the foundation is softened. In cold weather, the saturated foundation freezes and expands, heaving the pavement and often breaks the surface. Considering the destructive effect of impact at high speed, and of inadequate drainage, and the relative effect of these two factors on city pavements, it is believed justification exists for building heavier pavements in the country than in the cities.

Bridges.—Our State highway bridges are being designed and built for a loading of 20 tons, it being assumed that 75 per cent of the vehicle load will be on the rear axle. Under bridges spanning the highways, vertical clearance will be not less than 14 ft. from pavement to under side of girder.

Railroad Grade Crossings.—Railroad grade crossings are being eliminated wherever and as rapidly as practicable. In one instance of a section of the State highway now under construction, the relocation of the highway to parallel the railroad will do away with eight grade crossings within four miles; this includes the parallel tracks of two different railway systems.

Signs.—A comprehensive system of road signs is being installed to indicate direction, distance, dangerous crossings, curves and grades. These will be substantial, having concrete posts, and the inscriptions so designed and worded as to enable the motorist to proceed with the least inconvenience and loss of time.

Observing the singular lack of markers to enable motorists to proceed through city streets while en route from one city to another, and to quickly reach the trunk highway, we are making the street corners with a distinctive sign, which will enable tourists to pass from the State highway entering the city through the widest streets in the most direct manner possible, to the State highway leaving the city. At present there are few corners on through routes in large cities so marked as to expedite movement of through traffic.

The State Highway Commission has published and is now circulating an official map of the State highways, showing all State and county roads, indicating sections of routes under construction, and printed data concerning detours, to enable motorists to most conveniently avoid the construction work. This map and information will be revised from year to year as the work proceeds, so as to be always up to date.

State Will Pave Through Municipalities.—In order that there shall be no unpaved sections through small cities and towns on the State highways, the State will pave at its expense through all municipalities having a population under 12,000. With municipalities having a population exceeding 12,000, the State may enter and is now entering into agreement with such cities, by which each shall pay a portion of the cost. In many of the smaller communities the town authorities are paving from the State pavement to the curb. The routes of all State highways are so designated or laid out as to enter the large cities through their widest streets, so through traffic will not have to use the narrow, congested city streets. The county engineers of New Jersey, with the State Highway Department, have adopted a standard system of marking so all highways under county control will be thoroughly posted in the same manner as the State highways. These facts are cited simply to show that the coming needs are fully realized, and earnest effort is being made to provide for them.

Highway Requirements for the 20th Century.—Briefly stated, highway requirements for the 20th century transportation, as we see them, are the following: Ample funds, good alignment with flat curves and low grades; adequate sub-foundation drainage, the widest, strongest, toughest pavements obtainable; where they enter large cities paved widths should be several feet wider than in open country. Bridges designed for at least 20-ton loads, few or no railroad grade crossings; a comprehensive, thorough system of marking for distance, direction, and dangerous conditions; and a system of reasonable and enforced traffic laws which will protect all motorists, yet permit the expeditious movement of traffic.

Hot Mix Bituminous Pavements*

By F. P. SMITH,
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General Considerations Regarding Foundations.—The very desirable quality of flexibility possessed by bituminous pavements makes it necessary to provide a stable foundation. The character of the foundation required will depend upon the traffic, climate, character of subsoil and drainage conditions. The heavier the traffic the stronger must the foundation be. In cold climates where the ground freezes to considerable depth in winter, the spring thaws produce a very unstable condition of the subsoil and in such cases the foundation must be stronger than is required in climates where there is little or no frost. A well drained sandy soil is much less affected by these temperature changes than is a heavy clayey soil. In all foundations drainage is by far the most important single consideration. With adequate drainage a much thinner foundation can be laid than where it is absent or imperfect and the cost of proper drainage is often far less than the added cost of an adequate foundation on imperfectly drained ground.

A number of different types of foundations have been successfully employed, such as old macadam or telford; broken stone rolled dry or cemented together with some form of bituminous cement; old cobblestone, Belgian block or granite set pavements; old brick or asphalt block pavements; bituminous concrete; natural cement and portland cement concrete.

Where the traffic is light, as on country roads which are not main arteries from or between large cities and in some residential streets, old macadam or telford roads have proved to be suitable foundations for bituminous surface mixtures. In the opinion of the speaker, telford is preferable to macadam owing to the fact that the larger stones composing its base have a partial slab effect and therefore resist more strongly any pressure tending to displace them or to force them into the subsoil. In some cases, notably the Thames embankment in London, a macadam foundation covered with an asphalt pavement has successfully carried very heavy traffic, but the layer of stone has been built up during many years and is very thick and the drainage is nearly perfect. Under very severe conditions the use of macadam or telford as a foundation for bituminous pavements is to be deprecated and more failures than successes have resulted from it.

Utilization of Existing Pavements as Foundations.—Many roads are classified as macadam which contain no base course of large stone and are in reality old dirt roads which have never been properly drained and on which fine stone has been dumped and consolidated by traffic. Before using any macadam road as a foundation, its history, and more particularly its condition in the spring of the year, should be investigated. A sufficient number of test holes should be put down to determine the character and depth of the stone and provision made for proper under and side drainage. It will usually be necessary to rebuild the road in a number of places and in most instances the crown must be reduced. Wherever possible this should be done by filling up the depressions and building up the shoulders. Traffic will compact a road far better than will a roller and a road surface which has been scarified and rolled will not be as hard and firm as one which has been compacted by years of traffic. Where depressions are to be filled or shoulders are to be raised, the road bed should be cleaned and slightly loosened to insure proper bonding of the new stone, which should be of the same size as would be employed in building up the corresponding portion of a new macadam road. It should be thoroughly wetted and rolled with a 10-ton road roller with the addition of sufficient screenings until vehicles passing over it do not cause displacement. Unless this work [illegible] thoroughly and conscientiously done, the foundation will not be of uniform strength throughout, and settlements will occur where the new stone was put. If it is necessary to scarify the road surface, this should be done to the minimum possible depth, after which the surface should be built up exactly as if constructing a new macadam road and rolled until the utmost compaction is obtained. Wherever possible traffic should then be turned upon the road for a few months to develop any weak spot in it, and to secure still better compaction.

Old pavements of brick, granite, etc., should not be used as a base if it is first necessary to reset them. Relaid blocks, until bedded by traffic, are not rigid, and have a tendency to rock, and asphalt pavements laid on such foundations in New [illegible] they were exposed to heavy traffic.

Foundation of Bituminous Concrete. Bituminous concrete [illegible] types of it is made of run of the crusher stone from 2 in. down to dust, so graded and mixed with sufficient sand as to make a fairly dense and rigid mixture carrying about 6 per cent of asphalt cement. When this is kept clean and the wearing surface laid upon it at once, no binder course is necessary. It has less bridging strength than portland cement concrete and should only be laid on firm, well drained subgrades and is not suitable for very heavy traffic. It is usually laid from 4 to 6 in. thick. It is very slightly subject to expansion and contraction cracks and the overlying bituminous wearing surface, if properly laid, adheres to it very strongly, increasing its resistance to displacement under traffic. It is also water-repellant and underlying moisture will not be sucked up through its pores and attack the bottom of the wearing surface.

Concrete Foundations.—Portland cement concrete foundations vary according to conditions from 4 to 9 in. in depth and in every case before laying them the subsoil should be thoroughly compacted and drained. In certain localities in the northwestern portion of the United States and Canada very heavy clay soils are found, which in winter frequently develop cracks 4 to 5 in. in width and heave very badly. In such cases cross trenches should be dug every 25 or 30 ft. and filled with coarse broken stone and connected with longitudinal trenches at the side of the street, similarly filled and draining to catch basins. Concrete should not be laid directly on such a soil. Sand or gravel should first be spread upon it to such a depth that when rolled it will form a layer 3 to 4 in. in thickness and the concrete should be placed on this.

Wearing Surface.—This is composed of mineral aggregate and bituminous binder. The mineral aggregate constitutes from 80 to 90 per cent of the pavement, and takes practically all the wear resulting from traffic. It must therefore be selected with great care. It must be hard enough to carry the traffic; it must have clean grains or particles to insure the bitumen adhering to them, and these grains or particles must be graded from coarse to fine so as to make a pavement of the maximum density, with the smallest sized voids obtainable and with sufficient inherent stability to resist displacement under the shoving action of traffic. The surfaces of the grains or particles must be of such a character that the bituminous cement will adhere satisfactorily to them. Earth, sand, gravel, broken stone or slag, and finely ground limestone or portland cement or combinations of them, are the materials used in the type of pavements under discussion.

Earth is used in a special type of pavement which has been developed within the past 5 years. It should be of such fineness that at least 50 per cent of it will pass a 200-mesh sieve and it should contain from 15 to 70 per cent of clay, depending upon its character. This material requires a special kind of plant to handle it.

Sand should be clean grained, hard and moderately sharp. The grains should be chiefly quartz and should have rough pitted surfaces. Where necessary, the proper grading of the different sized grains must be obtained by mixing several sands or in certain cases by the addition of unweathered crusher screenings. When using the ordinary type of bituminous mixing plants the presence of clay is undesirable, either as a coating to the grains or disseminated throughout the mass. For medium or heavy traffic pavements all particles retained on a 10-mesh screen should be discarded. For [illegible] the sizes and in the amounts described under "Topeka Mixture." Sands containing a large amount of flinty grains should be avoided as bitumen does not adhere well to flint.

Gravel should be clean grained, hard and free from adhering clayey particles. It is lacking in stability owing to its roundness and is usually considerably improved by passing it through a crusher. Gravel with a rough pitted surface is to be preferred and gravel containing a large percentage of flinty particles is to be avoided. It is unsuitable for the construction of pavements carrying heavy traffic and inferior in all respects to crushed stone.

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*From a paper presented Mar. [illegible] before the [illegible] Roads Congress.

Broken stone should be freshly crushed preferably in cubical shaped particles. The size and hardness required depend upon the traffic which the pavement is to carry. Dense hard limestone will carry medium and light traffic satisfactorily. Where the traffic, even though comparatively light in volume, is composed of heavy iron tired units, a dense hard trap is required. Trap is now commonly used in the manufacture of asphalt block, although in the past a large number of asphalt blocks made from limestone gave excellent service under light traffic. Granite is not usually satisfactory, as it is too coarse and uneven in texture and much of it is friable and it is liable to shatter in crushing. Mesh composition or grading of the various sized particles is just as important as with sand. It is not suitable for use in pavements carrying very heavy traffic.

Hard, dense basic slag is to be preferred. It should be stable when exposed to the weather and not show any tendency to slack or disintegrate. It is only suitable for light traffic and should preferably be coated with a very fluid bitumen.

The filler should be finely ground limestone or portland cement, the latter being preferable for mixtures designed to carry extremely heavy traffic. For light traffic the speaker prefers the limestone dust, as it does not have such a marked drying effect.. Whichever is used, it should be ground so that at least 65 per cent of it will pass a 200-mesh sieve. Pulverized clay also makes an excellent filler, but is difficult to handle, owing to its tendency to ball and cake if it becomes the least bit damp.

Bituminous Binder, or asphalt cement as it is termed in the sheet asphalt industry, must possess such properties that it will firmly bind together the mineral particles and resist the disintegrating action of traffic and the elements. The necessary tests for determining whether or not it is possessed of these properties are fairly well standardized and are embodied in most standard specifications. The consistency of the bituminous binder varies somewhat with the type of mineral aggregate, but otherwise its general characteristics are about the same for all types of the pavements under discussion.

Out of the raw materials which we have discussed, four distinct types of hot mix pavement are laid. They are as follows:

Sheet asphalt, in which the mineral aggregate contains no particles which would be retained on a ¼-inch screen.

Topeka pavements, which usually consist of a standard sheet asphalt mixture to which has been added from 15 to 25 per cent of stone passing a ¼-in. screen and retained on a 10-mesh screen and approximately 10 per cent of stone passing a ½-in. screen and retained on a ¼-in. screen.

Bituminous concrete pavements (Bitulithic, Warrenite, etc.), having a mineral aggregate consisting largely or wholly of stone of varying sizes from 1½ in. down.

Pulverized earth pavements (National pavement), having a mineral aggregate composed wholly of pulverized clayey earth of such fineness that at least 50 per cent of it will pass a 200-mesh sieve.

The following are typical analyses of the foregoing types of pavements:

	Sheet asphalt		Topeka mixture, Per cent.	Bituminous concrete, Per cent.	Pulverized earth pavement, Per cent.
	Light traffic, Per cent.	Heavy traffic, Per cent.			
[illegible]	[illegible]	[illegible]	[illegible]	7.0	17.5
[illegible]	[illegible]	[illegible]	[illegible]	7.0	55.5
[illegible]	[illegible]	[illegible]	[illegible]	3.0	12.0
[illegible]	[illegible]	[illegible]	[illegible]	2.0	6.0
[illegible]	[illegible]	[illegible]	[illegible]	5.0	5.0
Passing 40 mesh...	11.0	14.0	10.0	4.0	3.0
[illegible]	[illegible]	[illegible]	[illegible]	3.0	1.0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	..
[illegible]	[illegible]	[illegible]	[illegible]	5.0	...
[illegible]	[illegible]	[illegible]	[illegible]	3.0	...
[illegible]	[illegible]	[illegible]	14.0	7.0	...
Passing 2 mesh...	...	...	[illegible]	20.0	..
[illegible]				14.0	...
[illegible]				12.0	..
[illegible]				5.0	..
	[illegible]	[illegible]	[illegible]	100.0	100.0

Sheet Asphalt Pavement.—Sheet asphalt will sustain a very heavy traffic. This statement applies more especially to a traffic largely composed of quick moving, light to medium loaded vehicles, such, for instance, as prevails on Fifth avenue, New York. It is not the most suitable type of pavement for a very dense, slow moving, heavily loaded iron tired traffic. Wood block and granite block will outlast it under these conditions. It will not give satisfaction where there is practically a total absence of traffic, as it then is liable to develop cracks, apparently requiring the kneading action of traffic to equalize the stresses set up by contraction and expansion and to keep it in proper condition. It is entirely suitable, however, for traffic varying from the light delivery traffic of residence streets to the dense but quick moving traffic of Fifth avenue, New York, or the Thames embankment, London.

On account of their smoothness, sheet asphalt pavements are not suitable for use on excessive grades. Generally speaking, streets carrying a fair amount of traffic can be paved with asphalt if the grade does not exceed 6 per cent. In some cases where the traffic was very light and a smooth pavement was considered essential, it has been laid on grades running up to 10 per cent and 12 per cent, but this is rather exceptional. Where the traffic is heavy, a 3 per cent to 4 per cent grade is usually considered as the limit. In most of the largest cities of the United States the maximum grades on which this type of pavement is laid vary from 4½ per cent to 8 per cent, regulated largely by the traffic and climatic conditions.

Generally speaking, the heavier the traffic, especially iron tired traffic, the finer should be the mineral aggregate used owing to the fact that the coarse particles are more liable to fracture than the smaller particles. Where fracture takes place to any considerable extent, rapid deterioration of the pavement will ensue, as the bituminous cement ordinarily used is not sufficiently fluid at atmospheric temperatures to rebond and recoat the fractured particles, and these will quickly be pulverized and washed out, leaving depressions where water will accumulate and eventually rot the pavement. Where the traffic, even though heavy, is largely or wholly composed of rubber tired vehicles, a greater proportion of coarse particles is permissible and desirable. In proper proportions they add greatly to the stability of the pavement and under conditions stated the light traffic mixture given in the table would be entirely suitable if the bitumen were increased to, say, 11 per cent.

The standard sheet asphalt construction of the present day is 1½ in. of binder and 1½ in. of wearing surface. The binder should be of the "close" type, i. e., should contain approximately 20 per cent of material passing an 8-mesh sieve and approximately 15 per cent each of ¼-in. and ½-in. stone.

A close binder properly made and laid will be superior in many respects to the mixtures which have been laid on a large number of country highways and will carry a fair amount of traffic for a considerable time without suffering any serious damage. Poor binder will break up very easily—sometimes it can be kicked up—and the hauling of the hot surface mixture over it will damage it very seriously. Surface mixture laid on a binder of this kind which has been badly broken up might almost as well be laid on loose broken stone and will not give satisfactory service under heavy traffic. The binder should, of course, be thoroughly compressed with a steam roller before laying the wearing surface on it. Lack of compression will produce an unsatisfactory foundation for the wearing surface, and binder which is too cold or made with too hard an asphalt cement or an insufficient quantity of asphalt cement can not be properly compressed into a dense, tough mass. In hauling the binder to the street over long distances or in very cold weather, it may become chilled below the danger point. During the hauling process a certain amount of surplus asphalt cement usually drains off of the stone and accumulates on the bottom of the cart or wagon. If these excessively rich portions be laid on the street, what are called rich or fat spots in the binder course will be produced. As the name implies, these are places carrying an excess of asphalt cement. If these are permitted to remain the surplus asphalt cement will be absorbed by the hot surface mixture when it is placed over them. This will make a soft spot in the finished pavement which will be displaced by traffic and eventually produce a hole or depression in the pavement. They should therefore be cut out and replaced with normal binder.

Before laying the surface mixture on the finished binder course the latter should be dry and swept clean of dirt; otherwise the layer of wearing surface will not adhere properly to it. Binder should be covered with surface mixture as soon as practicable after laying it. In many large cities it is required that all binder laid should be covered the same day with surface mixture.

Extreme care should be taken to insure a proper union between the surface laid on successive days. The first loads laid in the morning at the point of termination of the previous day's work should be a little hotter than normal so that the hot mixture may soften the cold edge of the pavement and bond perfectly to it. The joint should be beveled and freshly cut away unless the rope joint or a similar method is employed.

The practice of painting the edge of the joint with hot asphalt cement is not to be recommended, as unless extreme care is exercised too much asphalt cement will be used and that portion of the pavement will be too rich in bitumen and consequently softer than the rest, which will result in uneven wear and possibly shoving. Great care should be taken not to leave any hump or depression where the joint is made.

Topeka Mixture Pavements.—Topeka Mixture pavements are laid from two to three inches thick and are frequently placed directly on the foundation. Much better results are obtained by using a binder course 1½ in. thick next to the foundation with a 1½ or 2 in. wearing surface. This greatly reduces the tendency of the finished pavement to shove. With a well graded mixture a squeegee coat is unnecessary, although it is frequently employed.

The mineral aggregate as fed to the drier consists of a mixture of broken stone and sand which is liable to segregate in the bin. The hot aggregate should, therefore, be screened and separated into two sizes and kept in separate bins. Definite amounts of coarse and fine material should be weighed into each batch. Unless these precautions are observed, portions of the pavement will have an excess of coarse material and vice versa and the normal bitumen contents for an average mixture will be too rich for the coarse portion and too lean for the fine portion.

The bitumen content of these mixtures is somewhat lower than for sheet asphalt and must be very closely watched and kept within much closer limits than are necessary with sheet asphalt mixtures. One-half per cent above or below normal is about the permissible variation. Too little bitumen will make a pavement which is too open and porous and too much bitumen will render the pavement very liable to shoving.

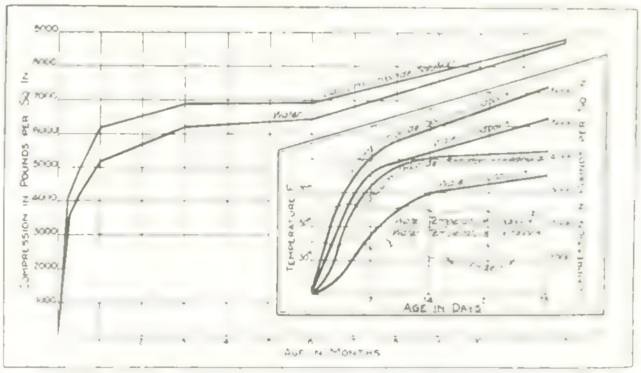
The general methods of manufacturing and laying and the precautions to be observed are substantially the same as for sheet asphalt.

Bituminous Concrete Pavements.—Bituminous concrete pavements have a mineral aggregate consisting wholly or largely of stone of varying sizes from 1½ in. down. Some of them are made of run of the crusher stone and some of them (Bitulithic, etc.) are made of carefully graded aggregates. Where the aggregates are graded it is customary to separate the different sized particles in from three to five bins and weigh out definite amounts from each bin for every batch. The normal bitumen content is lower than in Topeka mixture. An excess of bitumen will affect them in much the same way as a Topeka, but to a smaller extent. From 2 to 3 in. of the surface mixture are usually laid directly on the foundation. It is very difficult to completely close up such a mixture by rolling. It is usually, therefore, given a squeegee coat of hot bituminous cement, after which stone chips are spread over the surface and rolled in, the excess being left to be ground away by traffic. In some cases a thin layer of what is substantially a sheet asphalt surface mixture is used as a seal coat and if this practice is followed the pavement will carry a heavier traffic than if a coarse stone surface, liable to fracture, is left exposed.

Pulverized Earth Pavements (National Pavement.).—These are usually laid without any binder course and from 1¼ to 2½ in. in thickness. They are very rich in bitumen (15 to 20 per cent), but are extremely stable and so malleable that at a temperature of 60-75° F., a piece may be cut out of them and hammered back with a hammer and a perfect cold weld obtained. Their stability is due to the extreme fineness and absorbent properties of the mineral aggregate and for the same reason it is impossible to wear away the surface by any fracturing or grinding of the individual particles, as they have been reduced to practically their ultimate state of fineness before incorporating them into the pavement. In many respects they resemble the old French rock pavements, which had an unequaled record for long life. As compared with the French rock pavements, they do not become polished under traffic, but maintain throughout a very wide range of temperature, a consistency very closely approaching that of sheet lead, and as they contain from one and one-half times to twice as much bitumen, they are more waterproof and wear resisting. The clayey material of which they are composed has a much greater affinity for [illegible] than the other [illegible] paving material, which still further adds to their permanence. A National pavement weighs about 170 lb. per square yard 2 in. thick, as compared to 200 lb. per square yard for sheet asphalt of the same thickness. Their cost is somewhat higher than sheet asphalt owing to the large amount of water frequently contained in the mineral aggregate and the high percentage of bitumen used in them. They are capable of carrying the heaviest kind of traffic, and when properly constructed mark less in summer than do sheet asphalt pavements and are much less susceptible to shoving and displacement. They are equally suitable for very light traffic. The bituminous cement used in them is about 90 penetration at 77° F., which is much softer than is used in other types of mixed pavements. For this reason they do not become hard and crack even if not subjected to traffic for a considerable length of time.

Tests of New York State Department in Use of Calcium Chloride in Hastening Setting of Concrete

Tests completed last year by the Department of Construction of the New York State Highway Commissioner indicate that the use of calcium chloride in the mixing water increases the strength of concrete. The tests were made to determine the advantages in the use of calcium chloride solution to hasten the setting of cement concrete. It has been stated that by use of this solution concrete gun foundations could be put in use three days after construction. The tests made by the department were for the purpose of determining whether the rapid setting would decrease the ultimate strength which the concrete would attain. It is well known that abnormally quick setting cements do not usually make concrete which is as strong ultimately as the slower setting cements.



Results of Tests Showing Relative Strength of Mortar Cubes Mixed With Water and 4 Per Cent Calcium Chloride Solution.

[illegible] test samples were prepared and tested at ages ranging from [illegible] day to one year. The results are shown in the diagram, which is reproduced from the recently issued annual report of H. E. Breed, First Deputy Highway Commissioner in charge of the Department of Construction. They indicate that the use of a 4 per cent solution of calcium chloride in mixing water for cement concrete increases the strength [illegible]. Beyond that [illegible] the Department has indicates certainly no deterioration, and a probable continued, but slower, gain. The maximum in[illegible] appears to be [illegible] month.

The importance of this determination, states the report, will be appreciated when it is considered that by the use of this solution it will be possible not only for the contractor but also for the public to make use of cement concrete pavements a few days after they have been laid without [illegible]. It will [illegible] the completion of [illegible] in the autumn which has hitherto had to wait over unfinished until spring.

How to Analyze Business Prospects for a Rural Motor Express Route*

By J. A. COLLINS.

[illegible]

The [illegible] as an auxiliary transportation facility is [illegible] so new that its actual possibilities and limitations are not thoroughly understood even by those who have been [illegible] with the problems of highway transportation. It is but natural then that the development of rural motor express routes has proceeded on anything but a sytematic or carefully conceived program. Early efforts in this direction, therefore have been productive of much practical experience which will prove very helpful to those just entering the field of rural transportation.

The most common error of the beginner is not, as a rule, in the selection of his operating equipment, but lies rather in the failure to properly analyze his business prospects in advance. Because securing equipment involves the expenditore of money in advance, the ordinary operator usually exercises reasonable discretion in purchasing his rolling stock. Conversely, because of the fact that no direct outlay of money is involved, he fails to devote sufficient attention in advance to his business arrangements. The common assumption is that a proper volume of business will develop as the route becomes established as a regular carrier. The character of the business and its permanence appear as minor considerations.

Advance Survey Essential.—Where a new motor route is being considered it is essential that a careful survey be made in advance. A territory which appears at first glance to be admirably adapted to motor hauling may prove very disappointing to the man who actually undertakes to establish such a service. First-hand information can be secured only by a direct convass of the prospective field of operation. Such a survey to be of value must include all the primary factors which will mean success or failure, yet in actual practice these considerations are only the dictates of good business judgment. It will be found that two general factors influence the future of a rural motor route. These factors are: the volume of business or tonnage, and those surrounding conditions which have a direct bearing on the business.

Amount and Character of Tonnage to Be Moved Important Factors. Primarily of course, the profits of a route will very directly with the tonnage. The greater the prospective tonnage, the greater the profits, other factors considered. Equally important, however, is the distribution of tonnage throughout the season. The truck operator in a district producing grain exclusively, who has offered to him a greater tonnage than he can possibly care for during one month in the year and who has little or nothing to haul during the other 11 months, is obviously headed toward failure. It is apparent therefore, that the total quantity of agricultural products moving from the territory under consideration is not an entirely accurate guide for the prospective operator.

The ideal territory from the point of view of the motor operator, is the area whose total productivity is large, but whose products move to market in a fairly steady stream throughout the year. Regions given over to dairying, important truck farming districts, and areas of intensive but diversified farming have, therefore, proven most profitable to pioneers in motor transportation.

In making a preliminary survey, it is equally important that consideration be given to the character of the tonnage to be moved. Low priced, bulgy staples such as hay, as a rule, will not bear the motor truck tariff. On the other hand, perishables, which must move to market promptly if deterioration is to be avoided, may readily bear an express tariff because of the speedier service given by the motor truck. Light, bulky products require an undue amount of space and may not prove unprofitable as a load. In general, loads which have a high value per unit of weight or size offer the most profitable return.

Loads Need Not Be Confined Entirely to Farm Products.—Although rural express routes may be developed for the purpose of affording more adequate transportation facilities for agricultural communities, it does not necessarily follow that loads should be confined entirely to agricultural products. In many cases tonnage furnished by small industrial plants, country merchants, and city dealers with a rural clientele, has made possible the profitable operation of a rural motor route whose primary function is to serve the farmer. Few farming districts can support a motor route with a tonnage of farm products alone. The operator who serves the farm as distinguished from the rural community generally is pinning his faith to a rather slender support.

The original survey should also cover the return load feature. It is fairly safe to assert that no rural motor express route can exist entirely on a one-way load. Here again arises the necessity for establishing contact with commercial shippers whose dealings include loads both ways. Country merchants, as a rule, provide a considerable part of the load coming from the city, and the importance of this business cannot be overlooked.

External Factors to Be Considered.—There are a number of external factors which should be carefully canvassed in advance. The character of the roads over which the trucks must run is, of course, a prime consideration. If the road is poor, operating expenses may be so high per mile of operation that no ordinary tonnage will enable the operator to show a profit.

The wise beginner will carefully study existing transportation facilities in the territory he expects to serve. To offer service in a district in direct competition with established carriers whose service is entirely satisfactory, would show poor business judgment. If, however, the motor truck can offer a more direct outlet to market, can move perishable products more speedily, or can offer a more complete pick-up or delivery service, it may successfully establish itself side by side with older carriers whose service will thus be supplemented. The prospective operator should, therefore, pay particular attention to the schedules, collection and delivery arrangements, and rates of existing carriers. No set rule for motor rates can be set forth in advance. If rates on shipments by motor truck, however, are very much out of line with other local rates, it is obvious that no permanent business will be secured. Hence, a comparison of rates and service of established carriers is almost essential if the proper rate by motor truck is to be arrived at.

Getting in Touch with Prospective Shippers.—Coming directly to a consideration of the actual method of making a survey of a proposed rural motor route, it will be apparent at once that it will not be possible to personally interview every shipper or potential shipper in advance. Direct personal contact, however, is necessary to a clear understanding of the problem. There are several valuable points of contact available to the prospective operator. The county agricultural agent usually has an intimate first-hand knowledge of conditions surrounding the production and movement of farm products in his county. His suggestions will be based on a knowledge of local shipping conditions and cannot be overlooked. He is, therefore, to be considered as an unbiased source of much valuable information.

Local merchants may be approached from two angles, as prospective shippers, and as having fairly comprehensive ideas with respect to the transportation needs of the community. Part of the country merchant's stock in trade is his familiarity with local agricultural and commercial interests. His advance co-operation is therefore of great help. Local bankers also are abreast of conditions in their respective communities and can offer much that is helpful and informing. As a rule the local banker is in as close touch with conditions in his district as any person who could be approached.

The principal shippers among the farmers must also be visited, and their co-operation secured. If the important farmer shippers will contribute substantially toward the maintenance of a motor express route from the outset, the smaller farmers will soon fall into line. If the larger shippers will not support a route its ultimate success is very problematical. A fair check on the possibilities of a prospective route may be obtained by the operator who attempts to actually secure pledges on a part of his tonnage in advance. Of course advance pledges are out of the question in many cases, but the operator whose patrons evince a willingness to sign up in advance has a tangible evidence of the value of motor service to the community.

Transportation Survey Not Difficult.—In conclusion it may be said that no transportation survey can be outlined in advance in its entirety. Local conditions vary so markedly in different districts that a cut and dried program cannot be worked out which will be applicable to rural districts generally. In the main, however, certain basic factors must be considered and these must constitute the starting point of the survey. The considerations which have been discussed as generalities in this paper are basic in character.

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*[illegible] meeting of the National Highway Traffic Association, New York, N. Y.

A discussion of features to be covered in a transportation survey may leave the impression that such a survey is semi-technical in nature or is a cumbersome or elaborate piece of work for the practical man who desires to venture in the field of motor transportation. In actual practice, however, such a survey is surprisingly simple. The considerations which have been discussed as separate problems are seen grouped as one problem in connection with a survey made in any particular district. Considering the value of such a survey it is difficult to see how it can be neglected if a new motor route is to be successful from the start.

In the final analysis a transportation survey for a rural motor express route is merely the application of business foresight and judgment to a practical business proposition, and the actual conduct of such a survey can safely be left to the man who is guided by common sense rather than by technicalities.

Multiple Loading Stations Effect Economies in Handling Road Materials

When a source of materials for a road job is at one point at right angles to the highway to be improved, the materials may easily be brought on the contract at more than one point, in which case very considerable economies can be secured by the establishment of more than one loading station. The following example of the methods of hauling for such a job are taken from "Blue Print Suggestions on Roadwork," a recent publication of the Koehring Machine Co., Milwaukee, Wis.

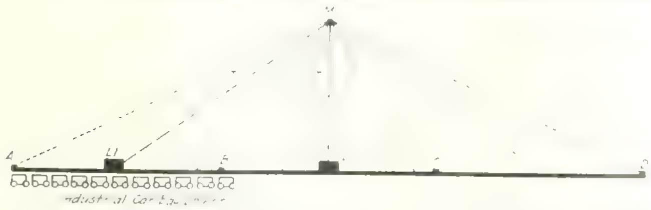
In the diagram, A to D represents several miles of highway and M the source of materials.

Establishing a loading station at L-1, the first working unit would require industrial car equipment from A to B, operating two mixers from A and B toward L-1.

The next working unit would be from B to C, with loading station at L-2, operating two mixers from B and C toward L-2.

As fast as the work is completed from B, the car equipment from the B end would be transferred to the section from C to D, so that by the time the B to C section is completed the industrial car line is complete from L-2 to D and two mixers are ready to complete the remaining section from C to D.

This handling of the work requires about two-thirds less industrial car equipment offering the advantage of short industrial car hauls, which is easily regulated to the operation of the mixer. In fact, the requirements of industrial car equipment are less than two-thirds, because in the longer haul more cars are required as a reserve during the transit of the train over the long haul.



This Diagram, Representing a Contract for Several Miles of Highway, Shows How Such a Contract May Be Divided Into Small Working Units Resulting in a Saving of Haulage Equipment and an Increase in Efficiency.

In addition, the double loading station plan affects a considerable handling economy from the source of materials to the loading stations to the subgrade. A single loading station in the center of the contract would compel haulage from M to the middle point of the contract. Multiple loading stations bring the materials in more direct line to the work as it proceeds along the lines T and T-1.

When materials are placed on subgrade without loading stations, haulage from source of materials may be direct from M to its destination on the subgrade, as is represented by the light dotted lines.

Views of Secretary Houston Regarding Creation of Federal Highway Commission

Secretary Houston [illegible] a city Chamber of Commerce requesting his views regarding the creation of a Federal Highway Commission and the wisdom of [illegible] Federal [illegible] Department of Agriculture [illegible] mission, has sent the following reply:

"I have your letter of May 2 in which you state that your Chamber of Commerce [illegible] calling on the Congress of the United States to create a Federal Highway Commission and that you note that such resolution has been adopted by a number of commercial organizations, including the United States Chamber of Commerce. You ask for an expression of my views on the matter and particularly whether, in my opinion, it would be wise to take the Federal supervision of highways from the Department of Agriculture and place it under such a commission as that proposed.

"Before expressing my views, it might be well for me to point out certain fundamental considerations which should be borne in mind in determining any sound policy of highway administration and development: (1) The roads in each section of the country are of varying degrees of importance in the service which they render or may render to the particular locality, to the state, and to the nation as a whole; (2) This is a big country and the traffic conditions and needs vary greatly from section to section; (3) The State Highway Departments, being in immediate touch with local conditions, are best able to classify the roads properly on the basis of the economic purpose which they may serve; (4) The Federal Government, under the present Bankhead Federal Aid Road Act, is co-operating in the improvement of the roads of greatest importance, the classification of which is fixed by the State Highway Departments; and (5) When this classification has been carefully made and by agreement between the highway departments of adjoining states, the roads of first importance generally meet at state boundaries, and, therefore, become interstate highways of nation-wide utility. The Federal Government, under the present law, is aiding the state highway departments in the classification of their roads on the basis of importance and needs, and Federal aid is rapidly being extended for their improvement, on projects submitted by the states and approved by this department.

"Having these points in mind, I have been unable to see the need for the creation of a separate Federal Highway Commission or the wisdom of substituting for the present co-operative program a plan which would commit or limit the Federal Government to the construction of two Federally-owned and maintained trunk lines in each state of the Union. There was a bill introduced in the Senate of the United States on Feb. 13, 1919, embodying these suggestions. This proposed legislation provides for a Federal Highway Commission of five, each receiving a salary of $10,000 a year, whose duty, among other things, would be to establish, construct and maintain a system of highways 'to comprise not less than two main trunk line roads in each state, and joining the National Highway System in the adjacent states and countries.' The Commission is given the power to select the trunk line roads to be constructed after having requested the State Highway Departments to recommend routes. The Federal Government is to assume the maintenance of these roads. The Commission is furthermore empowered to take over the work of all existing Federal agencies relating to highway transportation and 'to purchase [illegible] operate, and [illegible] transportation facilities as it may deem necessary in performance of its duties under this Act.'

"In July, 1916, the Bankhead Road Act was passed. It provided appropriations out of the Federal Treasury, to be matched by equal sums from the states, for the construction of roads, and provided further that no state should receive any of the money appropriated unless it had a highway department with adequate powers. The law placed the admin- [illegible] culture, in co-operation with the 48 state highway departments. It was enacted only a short time before we entered the [illegible] aid road co-operation was necessarily greatly interfered with by the disturbed conditions. There were also certain features of the law that made its smooth administration difficult. After the cessation of hostilities with the approval of the President I requested Congress to make a large additional appropriation to aid the states in highway construction and also to make certain amendments to the law the necessity for which experience had demonstrated. Congress, through the Bankhead amendment to the Post Office Appropriation Bill, provided an additional appropriation of $200,000,000 and substantially made the amendments suggested.

"Under existing legislation, there is no special obstacle, so far as I can see, to the construction, in the different states of the [illegible] of these roads which serve the greatest economic needs. In the first place, the definition of the kind of roads that may be constructed has been greatly broadened and, in the second place, the limitation on the Federal contribution for any one road has been increased from $10,000 to $20,000 a mile. Following this legislation, the regulations governing the administration of the act and the standards for plans, specifications, and estimates have been modified and one of the most successful former state highway engineers in the country has been placed in immediate charge of the Federal Aid Road work. He has at his disposal a considerable staff of local and district engineer aids and no pains will be spared to provide any further Federal assistance that may be needed. The machinery provided by the Bankhead amendment includes not only the Federal Bureau of Public Roads, one of the largest and most effective organizations of its kind in the world, but also the 48 state highway departments, the two agencies working in close co-operation. It is also a part of the plan to have an advisory committee, composed of representatives of the State Highway Departments, selected by the American Association of State Highway Officials with due regard to geographic considerations, to work in intimate touch with the Federal Bureau, meeting with its officers at stated periods and at such other times as may be necessary. This machinery, in effect, is an expert national commission intimately in touch through its various parts with all sections of the Union, having no other purpose than that of serving the public interest. It is difficult to see what need there can be for additional machinery.

"Very properly the Bankhead Act places on the highway authorities of the several states responsibility, in large measure, for selecting the roads to be constructed. Obviously, the local authorities are in a better position to judge what roads would serve the largest economic needs than any group of men sitting in Washington would be. It is the duty of the Federal Bureau, with its district engineers, to see that the provisions of the law are complied with. It is giving, and will continue to give, all possible assistance to the state authorities in all their technical problems as well as in the planning of state systems and in the classification of roads. It has been the policy of the department from the outset, in order to prevent haphazard action, to have the state highway authorities prepare and present tentative state systems of roads. It was apparent that a rigid system, not subject to modifications as conditions might require, would be inadvisable. Each state authority has worked out a system and, in general, it is being followed in the development of projects and the construction of roads. In a number of instances systems in general terms have been adopted by state legislatures. Of course, in formulating these systems, the engineers gave due regard to interstate connections, that is, to roads connecting the system of one state with that of another and it is difficult to see why, as progress is made, the construction of through roads will not follow as a matter of course.

"It seems scarcely likely, in view of the fact that nearly $300,000,000 are now available out of the Federal Treasury, that the Congress, in the light of the financial situation, will make additional large appropriations; and it would be impossible, without creating many complications, to divert the existing appropriations from the purposes and plans already under way under the co-operative arrangements with the states. A considerable part of the available appropriations has already been formally tied up under agreements with state departments and contracts for large sums have been let. Additional large amounts are being pledged monthly. Every state has accepted the Federal Act and many of them have by law directed its agencies to co-operate with the Secretary of Agriculture. A number of the states have large sums available for co-operation, in many instances much in excess of what is necessary to meet the requirements of the Federal Act, and other states are preparing greatly to increase their appropriations. These state laws and arrangements cannot easily be changed and perhaps would not be. After the original act was passed, more than a year elapsed before many of the states were able to secure legislative action which would enable them to comply with the Federal law and to begin the construction of roads. With the passage of the amendment carrying a large additional appropriation, there arose a necessity for further legislative action in some of the states. It seems to me that, instead of asking for more or different legislation, we should now proceed actively and vigorously with the construction of roads under existing arrangements.

"I am convinced that nothing material would be gained by the proposed change. Much would be lost. As has been pointed out, many complications would be introduced. The creation of a commission would entail unnecessary additional administrative expenditures and the commission could not do anything that cannot now be done more effectively by the existing co-operative machinery. There would also be a radical change of policy. I do not think that the people of the states will be willing to substitute for the present policy of developing roads on the principle of serving the largest economic purposes that policy advocated by those whose interest is in two main or trunk line automobile roads in each state, nor do I think that they would be willing, even if it were legal or practicable, to have existing funds diverted from the present or contemplated projects, worked out with the aid of the state highway departments, solely to the construction of such roads. The largest service will be rendered, not only to farmers, but, in the long run, also to urban people, by following the principle of constructing roads of the greatest economic importance, selected after careful consideration by the state agencies having adequate knowledge and approved by the Federal Department. It seems to me clear also that, as the work proceeds, we shall have roads which will be equally serviceable not only to those interested immediately in long distance automobile travel and motor truck transportation, but also to those interested in getting their farm produce to the market in the easiest and the most effective manner and in the transportation of the mails. I have no prejudice against any sort of road except a bad road, or against any sort of construction except wasteful and unsubstantial construction. If traffic conditions require heavy construction, then I am in favor of it; and in any case, under the law, the construction must be substantial.

"The road construction movement is growing very rapidly. The Federal Aid Road Act has done much to promote it. It has stimulated financial aid and has caused many state legislatures to create central highway departments. Experience has brought about amendments to the law and helpful changes in administration. Comprehensive road programs have been inaugurated. They are being pushed vigorously. They will result, in a shorter time than most people imagine, not only in a network of good substantial roads in the various states of the Union, but also in the requisite interstate highways.

"Why at this stage introduce complications and embarrassments? Why should not the friends of the movement for roads to serve the people co-operate? It is difficult for me to see why all who are animated by high public spirit in their thinking concerning highways should not co-operate in the development of present programs and in the perfection of the existing processes and machinery, instead of attempting to overthrow them. I believe that many of those who are backing the proposed change do not know the facts and are not aware of existing conditions and possibilities. I believe also that their proposal stands very little chance of being enacted into law."

Two Counties Vote $10,500,000 of Bonds for Road Improvements.—Voters of Dallas County, Texas, on May 24 authorized a $6,500,000 bond issue for the systematic improvement of county roads. By a vote of 14 to 1 Maricopa County, Ariz., on May 17, authorized a $4,000,000 bond issue for building 172½ miles of paved highways.

Road Machinery*

By ARTHUR H. BLANCHARD,

Consulting Highway Engineer, New York City.

The high wages of unskilled labor in 1917, 1918 and 1919 and the uncertain status of the labor supply of the future has resulted in a thorough analysis of highway construction data to determine economical methods of using road machinery. The trend of wages of unskilled labor was ably covered in the 1919 Report of the Committee on "Unskilled Labor Supply" of the American Road Builders' Association, wherein it was stated that the average rate per hour in the United States in 1912 was 19 ct.; in 1913, 20 ct.; in 1914, 20.5 ct.; in 1915, 22.5 ct.; in 1916, 26 ct.; in 1917, 30 ct.; and in 1918, 39 ct. In the opinion of the writer, American highway officials must face high wages for unskilled labor for several years. The basic economic law of supply and demand naturally applies to labor conditions. It is not probable that the war shortage of unskilled labor will be changed over night. It is not logical to expect that unskilled labor, which entered the Service, will rush back to the pick and shovel after demobilization. Emigration records show that thousands of laborers are leaving America every month. Immigration, the usual source of supply of unskilled labor, is an unknown quantity and agitation in the United States for restricted immigration further complicates the situation. It is not surprising, therefore, that the reconstruction period finds highway officials, engineers and contractors investigating all types of labor saving machinery.

The selection of equipment for the construction and maintenance of highways should be based upon a consideration of the following factors: (1) Character of work; (2) specification requirements covering plant equipment; (3) amount of work; (4) portability of plant; (5) large and small units; (6) ease of manipulation; (7) adaptability to different classes of work; (8) funds available; (9) depreciation of plant; (10) transportation facilities. The practical necessity for the consideration of many of the above factors is self-evident.

Character of Work.—In the case of contractors whose work is confined to the construction of sheet asphalt pavements and in the case of a department such as, for instance, that of Wayne County, Michigan, where the highway work consists primarily of grading operations and the construction of cement concrete pavements, the problem is materially simplified. On the other hand where a contractor's work covers the construction of all the various types of roads and pavements used in a municipality, county or state, the selection of the several units of plant equipment should be based upon their adaptability to different classes of work. For example, where cement concrete pavements as well as concrete foundations are to be constructed, in many cases a type of mixer should be purchased which is satisfactory for the construction of pavements, the requirements for which are more specific than in the case of mixers used only on foundation work.

Specification Requirements Covering Plant Equipment.—In the modern practice of highway engineering, many specifications include stipulation which must be met by machines and accessories employed. As illustrations might be cited the weight of rollers, pressure limitations in distributors, grouting apparatus, and details of mixers for the manufacture of bituminous concrete.

Amount of Work, Portability of Plant, Large and Small Units.—It is evident that a contractor for a department will be justified in the purchase of an ideal equipment if the work is to be extensive in character. If the work is centralized and large in amount, as in the case of sheet asphalt work, in many municipalities a large, well equipped permanent plant will prove economical. If, on the other hand, the work is large in amount but distributed over considerable area, small portable units will prove more satisfactory, as in the case of mixing plants for the manufacture of bituminous concrete to be laid on provincial highways.

Ease of Manipulation.—In cases where contractors are engaged in general highway work and their organization does not include foremen who are specialists in the manipulation of various types of complicated machinery, it is of utmost importance that simplicity of machines and ease of manipulation should be given great weight in the selection of equipment [illegible] particularly [illegible] connection with [illegible] types of [illegible] used in the construction [illegible] surfaces, bituminous macadam and bituminous concrete pavements.

Adaptability to Different Classes of Work.—It is well known that specifications for different classes of work, requiring the same type of machine, call for differences in detail. For grading work, specifications might require rollers weighing from 12 to 15 tons, while in the construction of wearing courses of some types of pavements [illegible] roller is stipulated. A contractor who is handling a small amount of general highway work would, therefore, find it advantageous to purchase a 12-ton roller suitable for both classes of work mentioned above.

Funds Available. Departments and contractors are necessarily forced to consider first cost of equipment, as the funds available may not permit the installation of the most economical and efficient machines. It may [illegible] conditions are encountered, it is obvious that it will not be practicable to anticipate that the work can be accomplished with the same degree of rapidity and at the same cost as if more efficient machinery constituted the plant equipment.

Depreciation of Plant Equipment.—Depreciation charges on plant equipment should be given careful consideration prior to the purchase of machines and accessories as well as in the consideration of the cost of highway work.

Transportation Facilities.—Facilities for the transportation of machinery and materials materially affect the efficiency of the several units of plant equipment. For example, in municipalities and provinces where materials may be transported over highways in good condition, the use of the motor truck will usually be found desirable.

Brief consideration will be given to the plant equipment suitable for grading, quarrying, construction of the several types of roads and pavements, and snow removal. It is also evident that normal conditions usually will be assumed as the basis for suggestion of plant equipment for the various items of highway work enumerated.

Transportation Equipment. Motor trucks and [illegible] usually will be found a necessary part of the equipment for all classes of highway work. Tractors and trailers are proving of particular value on long haul work where loading and unloading apparatus require motor trucks to remain idle during several hours a day. Industrial railroads have proven efficient equipment on highway work where a large tonnage is to be handled quickly on long hauls.

Grading.—Grading operations vary from the scarifying of an old road surface preparatory to the [illegible] wearing course, to heavy cut and fill work requiring the moving of thousands of cubic yards of material. It is apparent that only extreme conditions can be mentioned in this discussion as the economics of the utilization of various [illegible] of machine on average grading [illegible] necessitate a comprehensive discussion. For the lightest class of grading mentioned, scarifiers drawn by rollers have proved more economical and efficient than the use of picks in roller wheels or any one of the several types of plows drawn by rollers or tractors. For the heaviest class of grading work, in many instances steam shovels loading into wagons will be found economical. In connection with all grading work except light scarifying, one or more of the following types of machines should form a part of the plant equipment for grading: Road drags, grading and rooter plows, drag, buck and wheel scrapers, elevating graders, and rollers. It should be noted that the utilization of the elevating grader has not been fully developed by many contractors.

[illegible]

For many classes of grading work, their use is more econom[illegible] employment [illegible] features which should be based by a contractor for grading [illegible]

[illegible]

[illegible] marily upon the kind of rock, the required output per day, and the length of time during which the quarry will be [illegible] all equipment for rock work. Contractors or departments working the quarry to supply material for a specific highway would use the ordinary portable crushing and screening plant consisting of boiler, engine, jaw crusher, elevator, screen and bins. Small quarries, more or less continuously operated, are generally equipped with the above plant except that in many cases the gyratory crusher proves more economical. Passing to the largest quarries, modern equipment for the economical manufacture of broken stone should consist of steam shovels for removing the rock masses from the quarry face to steel cars. In such quarries the pieces of rock transported to the crusher may vary in size up to masses weighing 7 or 8 tons. The rock should be first crushed in a mammoth jaw crusher from which the rock should be passed through a series of gyratory crushers, jaw crushers and rolling mills and thence to elevators, screens and bins. In some plants of this type washing devices are a necessary part of the equipment in order to produce stone chips free from dust.

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*Paper presented May [illegible] at the Sixth Canadian Good Roads Congress.

Earth Roads. In the construction of earth roads on a large scale, the following equipment has been found to be economically efficient: Elevating grader drawn by horses or by a tractor, scrapers, disc and straight tooth harrows, road drags, rollers and watering carts. The combinations of the machines mentioned which will be used will depend upon the amount of work, character of the soil and the cross section to which the road is to be built.

Gravel Roads.—Spike-tooth harrows, scrapers, road drags, rollers and watering carts constitute the equipment for the construction of gravel roads. Many engineers and contractors have found grooved rollers more satisfactory for this class of work than smooth faced rollers.

Broken Stone Roads.—The average equipment consists of harrows, rollers, and watering carts. For many types of construction and kinds of rock, rolling for long periods with 10 or 12-ton rollers has secured a better compaction and economical bond than in cases where 15 and 18-ton rollers have been used for short periods. Some contractors have found automatic screening spreaders a valuable addition to the plant equipment.

Bituminous Surfaces.—The equipment required for the construction of bituminous surfaces depends upon the amount and character of the work and the rapidity with which it must be accomplished. For example, the construction of a bituminous surface on a broken stone road will require an equipment of rotary brushes or coarse fiber brooms, bass fiber brooms, in some cases batteries of heating kettles, a distributor to meet specifications and adaptable for the distribution of the kind of bituminous material under conditions stipulated in the specifications, pouring cans, squeegees, and, in some cases, 5 to 10-ton rollers and hand-drawn or horse-drawn automatic stone chip distributors.

Bituminous Macadam Pavements.—The equipment will depend primarily upon the specifications and the kind of bituminous material employed. The usual equipment consists of batteries of heating kettles, a distributor, pouring cans, and a roller. The specifications covering certain features of the distributor may be specific, as in the case of the 1918 specifications adopted by the American Society of Municipal Improvements herewith quoted:

"The pressure distributor employed shall be so designed and operated as to distribute the bituminous materials specified uniformly under a pressure of not less than 20 lbs. nor more than 75 lbs. per square inch in the amount and between the limits of temperature specified. It shall be supplied with an accurate stationary thermometer in the tank containing the bituminous material and with an accurate pressure gauge so located as to be easily observed by the engineer while walking beside the distributor. It shall be so operated that, at the termination of each run, the bituminous material will be at once shut off. It shall be so designed that the normal width of application shall be not less than 6 feet and so that it will be possible on either side of the machine to apply widths of not more than 2 feet. The distributor shall be provided with wheels having tires each of which shall not be less than 18 in. in width, the allowed maximum pressure per square inch of tire being dependent upon the following relationship between the aforesaid pressure and the diameter of the wheel: For a 2 ft. diameter wheel, 250 lbs. shall be the maximum pressure per linear inch of width of tire per wheel, an additional pressure of 20 lbs. per inch being allowed for each additional 3 in. in diameter.

Bituminous Concrete Pavements.—The type of pavement, amount of work, the specifications and the kind of bituminous material employed materially affect the selection of the plant equipment for this class of work. Batteries of heating kettles and a roller are required for the construction of all types of bituminous concretes. Although the practice of contractors has varied to a considerable extent with reference to the weight and type of roller, many now favor the 10-to-12-ton tandem roller for all classes with the exception of Topeka bituminous concrete. Plants of many types have been successfully employed in the manufacture of bituminous concretes. Naturally the most economical and efficient work has been accomplished by a plant especially adapted for mixing the type of aggregate used. Generally, on highway work outside of urban districts, the portable plant proves most satisfactory. Dependent upon the plant accessories, the aggregate is measured by volume or weight before being dried or by weight after drying, the latter being preferable. The aggregate is usually dumped into bucket elevators, which discharge into rotary driers. In the best types of plants, the heated aggregate is then raised by bucket elevators and discharged into a small storage bin. As desired, the heated aggregate is drawn from the storage bin and allowed to fall directly into the pug mill mixer, or, preferably, first into a weighing box. The bituminous cement is weighed in scales on the mixing platform and then dumped into the mixer. After thorough mixing, the bituminous concrete is usually discharged into a wagon or truck, which the plant arrangement permits to be placed directly beneath the mixer. For pavements of the type of bitulithic, a rotary screen is a necessary adjunct to the plant. For these types of bituminous concrete in connection with which seal coats are employed, the equipment will necessarily be increased by the addition of hand-drawn distributors, pouring cans, squeegees, and, in many cases, hand-drawn automatic stone chip distributors.

Sheet Asphalt Pavements.—The plant equipment necessarily depends upon the amount and location of the work and the specifications. A tandem roller constitutes a part of the equipment for all sheet asphalt work. The mixing plants are of three types, portable, semi-portable, and permanent. A complete plant includes a cold sand elevator, a drier, a hot sand elevator, a hot sand storage bin with screen, an asphalt elevator, a flux tank, melting tank, draw-off tank, a sand measuring box, a dust elevator, bin and measuring box, an asphalt cement bucket and a pug mill mixer.

Cement Concrete Pavements.—Variations in economical equipment depends primarily upon the specifications. A beam and bucket cement concrete mixer, forms, screens, bridges, belts, long handled light rollers, watering carts, pumps and hose usually constitute the equipment for the construction of cement concrete pavements constructed by the mixing method.

The essential features of a plant are covered by the following excerpts from a report of a committee of the National Conference on Concrete Road Building: "The concrete mixer should be of the batch type provided with an automatic water tank, traction drive and power loader. Mixers having a boom and bottom-dump bucket of sufficient size to convey one complete batch for placing the mixed concrete are preferred. Where necessary to keep from cutting into the subgrade and to facilitate moving, the wheels of the mixer should be run on suitable planking. The mixer should be provided with a suitable automatic water tank which can be quickly filled and emptied, so that when once determined, the required amount of water can be added to each batch of concrete. The power loader or skip should be of sufficient size to hold all the materials required for the batch."

Wood Block Pavements.—For the building of wood block pavements, the equipment should include the necessary apparatus for the construction of the mortar cushion, or a template and hand roller when a sand cushion is employed, a tandem roller weighing from 3 to 5 tons and the necessary distributing apparatus for the application of fillers and the construction of expansion joints.

Brick Pavements.—The equipment should include a wood template and hand roller for the construction of the sand cushion, a double metal template for constructing a mortar bed on a green concrete foundation, a tandem roller weighing from 3 to 5 tons, brushes, cement grout boxes or a small mixer if a cement grout filler is employed, or conical pouring cans if bituminous fillers are used for the construction of transverse or longitudinal joints.

Bituminous Macadam*

By A. W. DEAN,

Chief Engineer, Massachusetts Highway Commission

In the construction of this pavement, as in that of any so-called permanent type, proper drainage and foundations are absolutely essential. Moisture and frost action under the road crust are just as destructive as in the cheapest or most expensive pavements.

Foundation.—If the subsoil is a gravel or suitable sand, no artificial foundation may be necessary, but if of clay or other improper material, a foundation course consisting of stone or coarse gravel should be placed. If of stone, the interstices should be thoroughly filled with gravel to prevent the clay subsoil from gradually working up and filling the voids in the stone, thereby permitting the moisture to permeate and destroy the foundation and pavement during frost action

First Course.—Upon the properly prepared natural or artificial foundation the first course of broken stone should be spread evenly and to sufficient depth to be of the desired thickness after rolling. No universal rule can be made covering the thickness of this course, as the local conditions vary so extensively. For example, in some localities, the subsoil is of such nature, and the materials available in the immediate vicinity are of such nature, that an artificial foundation of stone 10 in. or more in depth may be laid and the first course of the pavement need be only about 2 in. in thickness. This is economical and satisfactory in localities where suitable stone for foundation is plentiful, but stone suitable for the first course of the macadam has to be imported at considerable expense. On the other hand, if the subgrade is a proper one so that artificial foundation is not necessarily used, the first or bottom course of the macadam should be not less than 4 in. in thickness after rolling, and, if heavy loads are to be sustained, a thickness of 6 in. is desirable.

The stone in this course should be of uniform and good quality, and should be spread in such manner that there may be no segregation of large or small stone. The stones composing this course may vary in size from ½ in. to 3 in. in their longest dimensions, provided, however, that the percentage of the small size shall be very small. If the course is 4 in. or less in thickness, the best results are obtained, however, by using stone varying in size from 1¼ to 2½ in. The same minimum size is preferable in a 6-in. course, but the maximum size may then be 3 in.

In laying this course the same methods should be used as in the laying of ordinary waterbound macadam, including thorough compaction by rolling, and securing a uniformly smooth surface. Unlike the first course is waterbound macadam, however, the voids in this first course must be filled with stone dust, fine gravel, or sand, in order to prevent wasting of bitumen by penetration into this course during the construction of the top course. It is essential that the surface of the bottom course be even and without depression before laying the top course. After the construction of this course is completed, all surplus dust and fine material should be swept off, leaving the upper stones bare to receive the second or bituminous course.

Second Course.—After the completion of the first course as above set forth, the second course is spread at such thickness that it will be 2 in. thick after rolling if for medium or light vehicular traffic, or 3 in. thick if for heavy vehicles in large volume.

It is extremely important that the stone used in this course be of good quality, uniform in character, and so spread that there is no segregation or large or small sized stones. If building for light weight vehicles only, the stone used may have a French co-efficient of wear as low as eight and a hardness value of eight, but for heavy vehicles a better quality of stone should be obtained if possible, using in such case a stone having a French co-efficient of not less than twelve, and preferably even greater, and a correspondingly higher hardness value.

The best and most lasting results are obtained if the sizes of the stone in this course vary from 3¾ in. to 2½ in., with the larger sizes predominating. This has been proven, even though it appears inconsistent, to use a 2½-in. stone in a course 2 in. thick.

Extreme care should be had in the laying and rolling of this course to have it uniform in its component sizes of stone and rolled to a uniform thickness. The rolling should be thorough, in order to reduce the voids and make the surface hard and smooth, although not as thorough as in the case of waterbound macadam roads.

Application of Bituminous Material.—After rolling, the bituminous material should be applied at a temperature of 250° to 300° F. with a mechanical distributor that will force the material onto the surface uniformly, such force being equivalent to that obtained under a pressure of [illegible] more to the square inch. The amount of bituminous material used per square yard in this application will vary from 1½ gal. on a 2-in. course to about 2½ gal. on a 3-in. surface. Great care must be had in the distribution of the bitumen to prevent getting too much or too little material in spots or streaks, otherwise [illegible] or depressions [illegible] the fault may cause, will soon develop.

After spreading the bitumen, it should be lightly but completely covered with pea stone (½-in. stone) and thoroughly rolled, using a 50-ton roller if available, and if the stone is of hard quality, or a somewhat lighter roller if of a poorer quality stone. Success will not be obtained if this course is not thoroughly rolled.

A seal coat of the same quality of bitumen is then applied, using ½ gal. of bitumen to the square yard for this application, then covering again with pea stone and finishing with the heavy roller.

When the bitumen is applied the stone should not be wet but may be moist, and in all cases must be absolutely clean and free from dust. The bitumen used may be an asphalt or tar product.

Whether of asphalt or tar, the bitumen should be properly refined and prepared for use in this type of construction, its properties varying slightly with the climatic condition of the territory in which it is to be used.

In northern climates like that in the New England states and lower Canada the best and most lasting results appear to be obtained by using an asphalt having penetration of 90 to 110, and as determined by the standard method of testing adopted by the American Society for Testing Materials.

Patching Bituminous Macadam.—Where properly built under suitable climatic and traffic conditions, the bituminous macadam pavement is economical both in construction and maintenance. If a hole appears in the surface it should immediately be patched, using a mixture of small stones and hot asphalt or tar. If a general breaking of the top surface appears imminent, it should be given a seal coat of hot asphalt and pea stone before such breaking up occurs.

Condensed Rules for Successful Construction of Bituminous Macadam.—A few condensed rules are here given for the prevention of unsatisfactory results with bituminous macadam.

Be sure that the drainage, subgrade and foundations are suitable.

Have the surface of the bottom course even and without depressions before laying the top course.

Have the larger sizes of broken stone predominate in the top course.

Use dumping platforms or self-spreading wagons for [illegible] broken stone.

Use a sufficiently hard bitumen for both penetration and seal coat, as a soft material permits the surface to soon [illegible]

[illegible] penetration [illegible] summer months. If done in the late fall the penetration is [illegible] in the following winter.

Patch holes immediately if they appear in the surface [illegible]

Pennsylvania Has Over $7,000,000 Worth of Road Work Under Contract.—[illegible] ment of Pennsylvania had awarded road contracts this year calling for an expenditure of $7,277,634. Four lettings, covering 56 projects aggregating 332 miles, had been held. It [illegible] been placed under contract.

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*From a paper presented [illegible] Association Congress.

Methods of Financing Highway Improvements

In a [illegible] embodied in a committee report submitted at the last annual convention of the American Road Builders' Association, Mr. J. E. Pennybacker, Chief of Management, U. S. Bureau of Public Roads, gives an excellent summary of the various methods that have been used in financing highway improvements in this country. His statement follows:

There are eight distinct sources of road revenues under the systems of administration followed in the respective states, counties and municipalities throughout the United States. These are: (1) personal taxes paid in labor and by an arbitrary capital tax known as poll tax; (2) direct property taxes; (3) proceeds of registration and license fees on motor vehicles; (4) direct appropriations from general treasuries; (5) special assessments on property in road improvement districts and against property abutting and contiguous to a designated road; (6) sale of bonds; (7) appropriations by the national government; (8) collection of tolls. Also, miscellaneous sources such as sale of land, profits from state industries, taxes on corporations, sale of permits, etc.

It may appear from the foregoing that the public road reaches all of the possible sources of taxation and theoretically this is true, but practically the general trend of road finance is toward a reliance upon direct property taxes, motor vehicles revenue, sale of bonds, and federal appropriations. The other sources are incidental and quite local in their application.

The labor tax has been ridiculed and condemned at every good roads meeting during the past decade. It is unquestionably an inefficient and wasteful method, both of paying taxes and building and repairing the roads, but it is probably the lesser of evils in the southeastern states, where a large proportion of the population holds little or no property, is thoroughly accustomed to manual labor as tenants of farms and plantations, and can only be reached effectively for the performance of civic duties through the imposition of a tax upon their manual rather than financial capacity. I should consider, therefore, that it might be desirable to consider the retention of some form of statute labor tax where the local conditions are such as I have described.

The direct property tax for road purposes probably will always be necessary both as to source of revenue and as a means of reaching all beneficiaries of road improvement, but many reforms and improvements are necessary before this method of finance can be held to really serve its purpose entirely. It is well known that the ratio of taxable to actual value varies not only among the states in wide degrees, but in many of the states there is a wide variation as among the several counties. Manifestly, if a state tax be levied for road purposes and the property in one county is assessed at 40 per cent of its actual value, while the property in another county is assessed at 60 per cent of its actual value, there is immediately an unjust discrimination against the latter county. The practice of equalizing assessments by state boards of equalization should be vigorously urged in connection with the levying of state taxes for road purposes.

In some of the states, cities are not taxed for county purposes and, in consequence, heavy automobile traffic from cities exerts a destructive influence upon country highways without any corresponding return in the form of taxes. The remedy is either to make the cities taxable by counties for road purposes or to include practically all of the heavily traveled highways in the state system and reach the cities by the direct state tax. It would seem to be fundamentally necessary that roads should be classified and segregated into distinct systems as a condition precedent to the establishment of direct property taxes. Probably some budget plan could be worked out in which the requirements of the state, county and township highway systems respectively could be ascertained, and the total tax rate then adjusted so as to yield amounts proportionate to such findings. The net outcome would be that the man who lived on the state road would pay the heaviest tax, the man who lived on the county road the next heaviest, and the man who lived on the township road the lightest tax, but each instead of paying three distinct taxes would pay one.

For the reason that it is easier to convince the public of the necessity of building a good road than it is to convince them of the necessity of keeping it up, I would advocate dependence upon the direct property tax as far as possible for the construction of state roads and for meeting interest and retirement requirements on state bond issues, thus leaving to motor vehicle fees the burden of first supporting state highway organizations and maintaining the roads, and applying only the surplus from such revenues to the construction of roads and the payment of principal and interest of bonds. For county and township roads it will continue to be desirable and necessary to levy the direct property tax for practically all highway purposes, less such amounts as may be granted by the federal government and the states as aid.

Proceeds of motor vehicle registrations and licenses have increased enormously during the past few years, and it is quite probable that in a very few years more the aggregate of this revenue will fall not short of $100,000,000 annually, or an amount greater than the total expenditure for highways and bridges in the entire United States 12 years ago. As suggested in the preceding paragraph, this revenue should first be applied to the support of highway departments and to the maintenance of state highways, for the reason that the revenues are regularly available without the irritation to the taxpayer which comes from levying a direct tax each year. In other words, having secured a good road, the average taxpayer is apt to consider the road as a permanent institution, and to resent the necessity of continuing to tax himself to keep it up, whereas, he is not so likely to oppose spending the generous motor vehicle revenues for this purpose. I believe, therefore, that it is a mistaken zeal which seeks to tie up motor vehicle revenues for the payment of interest and retirement of bond issues, thus leaving to the tender mercies of the taxpayer the roads built at great expense and for which debt has been incurred. If the state highway systems as distinct from local highways be estimated at 250,000 miles, and this is quite conservative, $100,000,000 would yield an average per mile of $400, and this amount would be reduced by such sums as would be necessary to sustain the state highway department. Under modern traffic conditions an average of $400 per mile per annum for maintenance is not an excessive outlay. In fact, many of the states consider an annual outlay of double this amount to be entirely conservative. I believe that this source of revenue should be jealously guarded as the one chief mainstay of highway maintenance.

Questions as to the basis of levying the fees on motor vehicles are interwoven in a very intricate manner with questions of regulation looking to the protection of the highways, so that the matter is not purely one of revenues. Thus far the tendency seems to be quite general to base the tax on the ordinary motor vehicle on horse power at rates now generally regarded as equitable at anywhere between 40 ct. and $1 per horse power, while motor trucks are more generally taxed on a weight basis. It would seem that there has been too much of a tendency on the part of each state to follow precedent. There ought to be good possibilities for the working out of an efficient and equitable basis of motor vehicle taxation through joint action of the best-informed men in those state highway departments which have had most intimate contact with this problem. The findings of such a committee would be exceptionally helpful to all of the states.

Direct appropriations from general revenues are practicable in large and wealthy states and municipalities, but in view of the urgent necessity of carrying on highway construction and maintenance according to a comprehensive system and over a period of years, the dependence upon annual appropriations is too precarious to permit dependence upon this plan except for special and temporary purposes.

Special assessments in road improvement districts constitute a method of finance quite generally followed in some of the middle western and southwestern states, and practically means the formation of a corporation of landowners who voluntarily bring upon themselves taxation for the purpose of improving their property by means of better highways. This method has proven successful in obtaining improved roads which would probably not be obtained through dependence upon popular vote. It localizes the burden, however, and is not equitable unless the road is of purely local importance. Any road used by traffic outside of the improvement district should have a wider field of taxation.

Bond issues for highway improvement are becoming popular at a rate which is not altogether reassuring. A brief consideration of authorized or suggested state bond issues, entirely apart from county and municipal issues, brings out the fact that if all of the proposed issues were approved, the states would saddle themselves with a financial burden exceeding half a billion dollars and possibly reaching a billion dollars. Certain fundamental questions, such as the length of term of the bonds, their payment on a serial rather than a sinking fund basis, the rate of interest, the determination of the roads to be improved, the solving of the difficult problems of type and dimensions of roads, should be worked out ahead of the sale of bonds so that these vast outlays may not produce such niggardly results as to cause a reaction, such as in the early days of the republic caused most of the states to insert in their constitutions provisions against taking part in works of internal improvement.

The collection of tolls, while generally tabooed by intelligent public sentiment, may yet assume a position of real importance in the financing of road work. In the old days objection was made to tolls because they were usually collected by private companies on public rights-of-way, because the cost of collection was out of all proportion to the amount of revenue derived, and because it was impossible to prevent gross dishonesty. It is possible to meet these faults by having the toll collected by the state and not by private companies. Traffic has become so enormous as compared with the old days and automatic devices for collecting and recording collections have been so highly developed as to make it possible to collect tolls at the cost of a small percentage of the total collections. The destruction to the roads of one tax jurisdiction by traffic coming from other tax jurisdictions naturally directs attention to the toll system as one means of meeting this condition. The toll system is distasteful and inconvenient to the road user and may be made unduly expensive, but on the general theory that payment should be made for service rendered, it would hardly seem that the road user could legitimately object to paying for the benefit of using a good road. I am not prepared to advocate the toll system, but consider that it should not be dismissed lightly as a relic of the barbarous ages.

Finally, the aid granted by the Federal Government has become of considerable magnitude. At present it is left to the state highway department in the first instance to determine where the federal aid is to be expended. It would certainly seem that the National Government should concern itself with those roads which are of national importance, and in line with this conclusion, the granting of federal aid should be restricted to a national system, or at least to those roads which are interstate in character. If this be done, it will be one more step in the logical development of the principle of apportioning burdens to each unit of government according to the benefits derived.

Why New York State Road Contractors Failed.—Ruinous competition by inexperienced contractors rather than war conditions is ascribed by Mr. E. A. Bonney, Supervising Engineer, New York State Highway Department, as being the cause of the unusual number of defaulted highway contracts in New York state in 1918. In the last annual report of the First Deputy Highway Commissioner, Mr. Bonney summarizes the matter as follows: It is the current custom to ascribe failure on public work operation to the war but this reasoning was only partially responsible for the various contracts which the Department was forced to complete. Most of the failures can be traced back to the ruinous competition of 1914, 1915 and 1916, brought on by the influx of many inexperienced contractors. In some cases a certified check for bidding purposes was obtained from a bonding agent: a bond procured from this agent's company; a plant bought for a few dollars plus 6, 9 and 12-month notes; the president of some rural bank procured as a copartner so that the first payrolls might be met; and finally the proceeds of monthly estimates were assigned to material manufacturers so that work could proceed. Such combination as outlined above, together with the gradual increase in the cost of labor, had far more influence upon the resulting abandonment of contracts than the entry of the United States into the world war.

Methods of Constructing Roads Through Sandhill Regions

Nebraska has a sandhill region covering an area of about 20,000 square miles or about one-fourth the total area of the state. Most of the area is dune sand without much vegetation to hold it down and prevent it blowing about with the wind. When undisturbed, grass and weeds [illegible] of vegetation that prevents its being moved by the wind. However, this mat is not sufficient to hold the sand in place under traffic. The methods of constructing and maintaining roads through this sandhill region were described by Mr. Paul E. Brown in a paper presented at the last meeting of the Nebraska Road Institute. The following is abstracted from his paper:

In dry weather the sand dries out to a depth of 4 in., where it is entirely free from vegetation. When sod covers the sand, the sand dries out to a depth of 14 to 18 in. in hot weather.

The moisture retaining faculty of the bare sand is a great benefit of the roads. The presence of moisture determines the condition of the natural road more than anything else; for the growth of vegetation as mentioned before, does not benefit the road much. The annual rainfall for the region is about 21 in.; while the evaporation is twice as much; and yet most any time one can find moisture within 2 or 3 in. of the surface of the ground.

While driving an automobile through the sandhills, places are sometimes encountered, where it seems impossible to get the car to move because of the dry, loose sand under the wheels. In such a case one can most always drive out by scooping the surface of the trail ahead of the car, for a depth of 2 to 3 in., until better soil is reached.

Since dragging and grading results in no benefits to a sandhill road, the only method left for improving them is to put some material on the surface. Or else mix something with the surface sand to act as a binder.

The method most used is to spread hay, straw, weeds or some sort of vegetation on the road to support the vehicles and distribute the weight more widely over the sand. Straw is usually distributed along the trail to a depth of about 12 to 18 in.

After travel has gone over the straw for about a week, the road is at its best. A few weeks, especially in hot weather, allows the straw to break up and gradually blow away, until such a road presents itself for a month or so. After that, hardly anything remains to show that the road is any different than it was before [illegible] there.

Another way of treating the sandhill roads that approaches a more permanent type of construction, is to haul clay from the valleys, or magnesia from the creek and river canyons, and distribute over the trail about 8 in. thick. The strip so covered is seldom over 8 ft. wide.

In dry weather the road does very well, but when wet it approaches the clay road of days gone by, being little short of a mudhole, except that the sand beneath offers some drainage. A rain or two, and a season of traffic, puts the wheels through the clay into the sand. The chuck-holes, that occur on a road like this, when breaking down, are terrible.

The clay treatment could be made to do 10 times more service if it were intermixed with the sand about half-and-half, and rolled, when a little moisture is present. Treated this way and given a slight crown could not help but present [illegible]

There are places where clay is not easily obtained and [illegible] Usually, in these cases, the traffic is so light that economy [illegible] the guard rail a 2x4 braced by a 1x4. The spiking would all [illegible] 1x4s or 2x4s. In all cases, they should be buried so that the track itself rests on the sand. By making the track complete in 10-ft. sections and joining the sections at the ends, each one partly overlapping the tie of another, the entire [illegible] ture conditions made it advisable to change its location.

The cost of such a track would be about $[illegible] a 10-ft. section for material alone and about $265 a mile. The construction would perhaps equal this figure, if the work were to be done by the public, but when done by the individual for private use, as in the case of a ranch or a neighborhood, the material and labor combined would hardly exceed $8 a 10-ft. section or $425 a mile.

The Field for Rural Motor Express in New York State*

By JAMES E. BOYLE

(Extension Professor in Rural Economy, College of Agriculture, Cornell University)

We know that in comparison with the railroads of other countries, our railroads carry lower capitalization and give better service at lower rates. However, this is not saying that the railroads are successfully meeting the needs of newer forms of transportation developed since the coming of the gasoline engine. Improvements in railroads in recent years have largely taken the form of putting on heavier rolling stock and hauling increasingly heavier loads; an increasing use is also being made of electric power and of gasoline motors. But whatever the causes may be, in the past few years transportation needs have outstripped railway development. This is true not only along the branch lines and feeders for the main lines, but along the main lines themselves. The demand now is primarily for better service rather than cheaper service.

The growth of transportation facilities should keep pace with the growth of population. And since rural population has been steadily decreasing in most New York counties, it might seem, on the face of it, that there should be a corresponding decrease in rural transportation facilities. But this is not the case. There has been a shift in population. Most decreases in rural population have been offset, and more than offset by the increase in the nearby city population. This shifting of population has doubtless made certain branch lines of railways extremely unprofitable to maintain and operate. Railways, being fixed to the soil, have not been able to meet these shifts in population. A shifting of population requires a new allocation of transportation routes, or a change in transportation methods.

In view of the facts just stated, we see then the need of a rural motor express service serving approximately the area served by some of the branch railways, and probably extending the service a little farther back into the country. This would involve the junking of the railway lines in such cases, a process now already begun in some sections.

New York is a state very thickly dotted with country villages back in the hills and along the valleys, and hundreds of their stores are not located on the railroad. Many of these stores still use the costly method of horse-and-wagon transport to haul their supplies from the urban center where they have their trade connections. This means that a steady stream of heavy supplies such as flour and feedstuffs is moved over the country road in the most primitive and expensive fashion. A string of such villages could be organized into a rural motor express route, at a great saving to both the merchant and his customers.

Along the main arteries of railway transportation city populations have shown a tremendous increase. Here is where the intercity motor express has already reached a substantial development. It is a question whether or not the time has come for such intercity motor lines to develop a local service, reaching the small towns and villages not only on the main route, but tributary to it.

In the important dairy sections of New York, a rural motor express service is now needed to distribute the feed stuffs to the farms, and to collect the milk from farms. This traffic is heavy enough and constant enough, doubtless, to warrant such an investment.

Much fruit and produce grown in New York never reaches the consumer. Much of this stuff rots on the ground. For instance, it was my experience last fall to be in and out of several counties, and to note many hundreds of bushels of apples rotting on the ground, partly due to lack of labor and partly due to lack of transportation facilities. And only last week I inquired in eight stores in the city in which I live, for New York eating apples. None were to be had. But these stores had plenty of Oregon apples at 8 ct. apiece. There were enough apples rotted on the ground within 30 miles of my home city, without doubt, to supply the whole population for a year. With hay selling at $40 a ton, as it has been this spring, it is not likely that there will be a substantial increase in the horse population and in transportation facilities by horse-drawn vehicles. There is a big waste by freight cross hauls now which can be overcome by an adequate system of rural transportation. An investigation of the amount of produce shipped out of and of produce shipped into the state will reveal a big economic waste which must be added to the waste caused by rotting on the ground.

It is evident that the great increase in population in New York state as a whole and the shifting of population within the counties have rendered necessary and imperative changes and improvements in transportation facilities of the state. Evolution has produced the motor truck to meet the new conditions. The practical problem now is one of pioneering—who will try out the new methods, and where and how? It is only fair to state at this point some of the limitations which are to be met in organizing rural motor express lines.

The engineering problems do not fall within my field, but in a general way they may be mentioned. While New York has "good roads" when compared with some states, yet the lack of good roads is a condition confronting the rural motor express business. More mileage of better surfaced roads is needed, and will doubtless come as the motor truck lines develop. The two work together as cause and effect. An intercity motor express which recently failed was operating 5-ton trucks. The size of the truck is an engineering and an economic problem which should be capable of solution. So likewise is the question of repairs and the time lost on repairs.

The primary economic problem is the volume of business and its distribution. A well planned route should find business throughout the year and also business for the return haul.

The franchise question is one of the most serious ones, and one at present unprovided for. A heavy investment in the motor express business must contain at present a speculative element due to the lack of a standard franchise. A state law providing for the strict regulation of competition, of rates, and of other matters, under a franchise, and for a tax to be used solely for highway improvement, would tend to standardize the business. Wisconsin has a law prohibiting competition in certain public utilities. While it would not be desirable or feasible to prohibit competition in the rural motor express service, it would be highly desirable to so regulate competition as to furnish some safeguard to well-placed investments.

In talking with persons in touch with both the success and failure of motor express lines, I am impressed with the unique and peculiar importance of the human factor in this business—the driver of the truck. Here you have an expensive piece of machinery, in charge of a semi-skilled laborer, hired by the week, and operating far from the supervision of his employer. In fact, the driver of the truck clearly has it in his power to make or break the business. He seems successfully to defy all supervision thus far. He knows the machine is "not his." He will upset in the ditch occasionally. He will loaf at one point, and then overspeed the truck to the next point, removing the belt of the governor. In fact, the stories told about the deeds of these drivers are quite disheartening, with their drinkings, and carousing, and stealings, and general all-around cussedness. Evidently the problem is primarily one of hiring the right men and then of keeping them loyal by some scheme of recognition or advancements. In case of a large motor express company, trucks might well go in fleets in charge of an overseer. However, the question of honest and efficient drivers is one of fundamental importance. I am inclined to take the optimistic view of it and believe that such men can be had, and at reasonable wages. If they cannot be found, then it is time to take an inventory of our moral and economic resources, and, in the language of Jerry Simpson, "see where we're at."

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*From a paper presented [illegible] at the annual meeting of the National Highway Traffic Association, New York, N. Y.

Force Account Work by New York State Highway Department

Work on 15 cancelled highway contracts, aggregating 67.89 miles was carried on during 1918 by forces of the New York State Highway Commissioner. Of these jobs 14 were handled directly by the office of H. E. Breed, first deputy highway commisioner, the construction being carried out under the direction of Supervising Engineer E. A. Bonney. Interesting details regarding the work are given by Mr. Bonney in a report which is appended to the annual report of Mr. Breed.

In no case did the department seek out work to be performed under its own direct supervision. The various completion projects were started only when traffic conditions became unbearable and the traveling public suffered to such an extent that a remedy was imperative.

In carrying on this work a superintendent was procured who, as a first qualification, was a live, responsible contractor; who had not defaulted on any work with the department; and whose record for integrity and business acumen in prosecuting his own work was unquestioned. He was placed upon a straight salary basis and a rental agreement executed for such plant as was necessary to properly carry on the work. The plant rental prices were far below the going commercial rates and would stand comparison with rentals paid at any time and place.

A representative from the department was placed upon the work as engineer and timekeeper, if it were possible for him to do both. On some of the larger contracts two men were needed. Wherever it was possible, the individual laborers, mechanics, teams, etc., were paid by individual check, after signing vouchers and payrolls for the amount due them. Payment of wages was made twice each month and to the lasting credit of the auditor's office, no employes were lost during the summer because of failure to receive their compensation on time.

The rates for labor varied in different sections of the state from 30 ct. an hour to 45 ct. In no case was the rate paid by the department in excess of that paid by individuals in the same section. The labor was generally scarce, hard to procure and inefficient, at least in comparison to 5 years ago. The laborer knew that he could get work whenever he wanted it and cared less and less about his job as the season wore on. It was a most trying and difficult problem for the men in charge. Nevertheless, as the season progressed, the state force contracts showed a larger average of work per contract than the work carried on by individuals. The rate of progress also exceeded the other contracts. This was partly due to the co-operation which the department received from the Federal government in the procurement of cars to carry material, and possibly the preference shown it by manufacturers of materials and owners of quarries because its credit as a purchaser was unassailable. This was particularly true in the matter of coal.

The work in general was very satisfactory as to speed and quality. The costs were not excessive although the department faced a handicap of comparison at the start because most of the contracts were taken at extremely low figures and the contract prices were far below the cost of present day work.

Regarding this force account work Mr. Bonney concludes: "It is my belief that such work should not be carried on as a general practice. It places upon the department entirely too great an amount of detail and too much personal responsibility upon the engineers and superintendents handling it. It has proved in the last 2 years that it is possible and feasible as a last resort for a commissioner of highways. It prevents him from having his hands tied by willfully obstructive tactics of a surety company as evidenced in the past by their bidding in completion work at prices far below cost after which no work would be started; and provides the citizens of our state with relief when ordinary methods of procedure fail. When kept down to a minimum and used only in the extremity, the system has proved its value."

Cost of Feeding Horse at Cincinnati, O.—During 1918 the Department of Street, Sewer and Catch Basin Cleaning of the city of Cincinnati, O., maintained 210 head of live stock. In 1917 [illegible] while in 1918 the average was $0.633. The itemized figures for last year, according to the annual report of Fred Maag, Superintendent of Street Cleaning, were as follows:

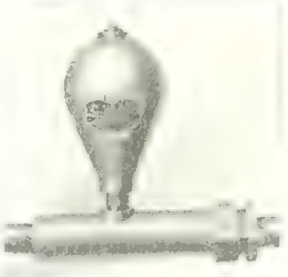
H[illegible]	[illegible]
O[illegible]	[illegible]
N[illegible]	[illegible]
Total	$0.633

Special Tractor for Road Work

A tractor designed especially for road work has been placed in production by the John Lauson Manufacturing Co., of New Holstein, Wis. The machine was developed on suggestions and orders received from county and township highway commissioners. To insure proper traction and to prevent slip, heavy construction and solid cast drive wheels with 16-in. face and special lugs are used on the tractor. The drive wheels are equipped with a flat cleat, developed after extensive experiments under most severe conditions of road building. It is claimed that this lug will not tear or injure the smoothest roadbed. The working parts of the tractor are enclosed in a dust-proof housing and all gears run in a bath of oil. The engine is rated at 15-30. The cooling system is controlled by a sylphon thermostat. The tractor is provided with a heavy solid draw bar, and also has a swinging draw bar for pulling scraper and other loads where a short turn is desired.

Lauson Special Road Tractor

Device for Preventing Breakage of Road Contractors Water Supply Line



Expansion Joint and Air Chamber for Water Supply Lines for Road Jobs.

Breakage in pipe lines conveying water for a road job often causes serious inconvenience to the road builder. This breakage in most cases is due to expansion and contraction of the line resulting from temperature changes. An expansion joint that prevents this trouble has been placed in production by the [illegible] Co., 284 Clinton St., Milwaukee, Wis. The joint consists of a [illegible] stuffing box. The pipe line is [illegible] located 800 ft. to 1,000 ft. apart. The joints can be furnished with an air chamber, as shown in the illustration, to take up [illegible] water hammer in the line.

Cost of Pavements at Little Falls, N. Y., for 17-Year Period. [illegible] Little Falls, N. Y. [illegible] expended $284,720 for constructing pavements. The yardage [illegible]

[illegible] 124,00[illegible]

Portable Aggregate Heater for Bituminous Concrete Roads

The proper heating of the mineral aggregate for bituminous concrete is an important factor in the success of this pavement. In fact failure of many of the earlier pavements of this type is ascribed to lack of uniformly heated sand or gravel due to the primitive hand methods then in use. A rotary heater, equipped with oil burners that is claimed to uniformly dry and heat the aggregate up to 350° F. without burning, or in any way impairing its quality, has been placed on the market by the Dyar Supply Co., 66 Broadway, Cambridge, Mass. With this machine the aggregate is fed or shoveled at a uniform rate into the charging end of the heater. The revolving drum through which it passes, agitates and turns the aggregates during the process of drying and heating, insuring a uniformly heated product. When the aggregate is heated to any temperature up to 350° F., depending on the oil, tar or asphaltic cement to be used, it passes into a receiving hopper. From here it is run by gravity into the charging elevator of the mixer. This heater has a capacity of 9 to 12 cu. yd. per hour. Its length over all is 23 ft., its width over all is 7 ft., and its weight mounted on trucks is 6,900 lb.

Municipal Bituminous Concrete Plant at Hingham, Mass., Showing Rotary Heater With Cube Mixer.

On this job the gravel was delivered to heater by horse scrapers and was screened as it entered heater by means of screen placed over charging end of drum. The mixer was so located as to permit loading by gravity directly into carts.

Asphalt Paving Contractors Form Association.—The Southern Asphalt Association, comprising the principal public works contractors engaged in laying asphalt pavements in the South Atlantic States, opened offices in Atlanta on June 1 in ducted in the interest of asphalt roads and pavements in the ducted in the niterest of asphalt roads and pavements in the South Atlantic States. The purpose of the association is to create a wider and better knowledge among public officials and taxpayers of the utility and advantages of asphalt for road and street purposes. This is to be accomplished by a general publicity campaign. In addition, the association will endeavor to keep experienced and skilled workmen steadily employed by putting them in touch with the members of the association who have need for their services. Walter Ely, president of the Ely Construction Co., Augusta, Ga., has been elected president of the association, and W. R. Mayrant, general manager of Simmons-Mayrant Co., Charleston, S. C., has been elected vice president. The following board of directors has been elected to serve for one year, and will determine the policy of the association: W. S. Ely, W. R. Mayrant, R. M. Hudson, president of R. M. Hudson Co., Atlanta, Ga.; Fred L. Connor, president of Murray Construction Co., Knoxville, Tenn., and W. R. Dunn, of the Dunn Construction Co., Birmingham, Ala. J. M. Woodruff, who recently resigned the position of manager of the advertising and paving department of the Standard Asphalt & Refining Co., Chicago, a subsidiary of the Cities Service Co., has been engaged as general manager of the association and assumed his duties on June 1.

Personals

Peter Junkersfeld has become associated with Stone & Webster as engineering manager, division of construction and engineering.

O. E. Eckert, formerly with the Engineering Division of the Michigan State Board of Health, has been appointed City Engineer of Lansing, Mich.

The Aberthaw Construction Co., of Boston, Mass., has recently opened a permanent office in Buffalo, N. Y., at 918 Ellicott Square. H. C. Hoddmer, who has been with the Aberthaw organization for seven years, will be in charge.

J. W. Howard has finished serving in the Ordnance Department of the Army and has resumed the practice of his profession of Consulting Engineer on Roads and Pavements, with testing laboratory in Newark, N. J., and office at No. 1 Broadway, New York.

Frank F. Fowle, until recently one of the receivers of the Central Union Telephone Co. and formerly consulting engineer, and James R. Cravath, well known consulting electrical and illuminating engineer of Chicago, have formed an engineering partnership under the firm name of "Fowle and Cravath," with offices in the Monadnock Block, Chicago.

John F. Druar, Captain Engineers, U. S. Army, has been discharged from service and has resumed his business as Consulting Engineer. Mr. Druar has been in municipal engineering business for the past 10 years. Associated with Mr. Druar under the firm name of Druar & Smith, Engineers, is Captain Roscoe L. Smith. Mr. Smith has also been discharged from the service. For the past two years Mr. Smith has served as water supply and fire protection engineer for camps and other army projects and for a large portion of the naval stations and ship yards in this country. He was also for some time on the staff of engineers maintained for the government by the National Board of Fire Underwriters. Druar & Smith will continue the business of J. F. Druar, doing general municipal engineering work. Their offices are at 513-14 Globe Bldg., St. Paul, Minn.

H. Eltinge Breed, recently First Deputy Highway Commissioner of New York State, will engage in a consulting practice with office at 507 Fifth Ave., New York City. Mr. Breed was graduated from Colgate in 1900. From 1901 to Jan. 1, 1907, he was in the Department of State Engineer and Surveyor of New York, passing through the various civil service grades to the rank of Assistant Engineer. During this time he had active charge of $3,000,000 worth of work, as well as the preparation of plans and estimates. During 1907 and 1908 he had charge as supervising engineer of construction and maintenance work in a number of counties. During 1909 and 1910 he was on barge canal work as auditor, and for special assignments in engineering. In 1911 he spent six months with the State Highway Commission on plans. For the next year he had charge of the Coleman du Pont road in Delaware as Assistant Chief Engineer. During 1912 he traveled abroad and studied pavements in France, Belgium, Switzerland, Germany, England and Scotland. From 1912-1915 he was in practice as Consulting Engineer. During this time he was interested in many pieces of highway and improvement work from the contractual side. From 1915 to date he was First Deputy Commissioner New York State Highway Commission, Albany, N. Y., acting as Chief Engineer of all new construction.

Obituaries

William B. Hough, a prominent engineer and dealer in contractors' supplies of Chicago, died suddenly May 29 of heart disease. Mr. Hough was born in Williamsport, Pa., in 1878 and was graduated from Massachusetts Institute of Technology in 1900. At the time of his death he was president of the Metal Building Materials Co.

Industrial Notes

Chalmers & Williams, Chicago, Ill., have established a Service Department for all types of crushers and other products manufactured by them. This department is under the supervision of Mr. J. F. Orr, sales manager, with Mr. J. I. McInrue as field representative.

The Material Handling Machinery Manufacturers Association has invited all manufacturers of mechanical handling machinery and equipment and accessories to attend a coalition meeting of the association to be held June 11 at the Hotel Astor, New York City. Zenas W. Carter, 35 W. 39th St., New York City, is secretary-manager of the association.

J. M. Woodruff has resigned as manager of the advertising and paving department of the Standard Asphalt & Refining Co., of Chicago, a subsidiary of the Cities Service Co., to accept the position of general manager of The Southern Asphalt Association, with headquarters at Atlanta, Ga. Mr. Woodruff was manager of the advertising and paving department of the Standard Asphalt & Rubber Co., Chicago, from 1909 to 1913, resigning to accept a position as southern representative of Warren Brothers Co., Boston, Mass., bitulithic paving contractors. He remained with this company from 1913 to 1917 and then resigned to accept the position of manager of the advertising and paving departments of the Standard Asphalt & Refining Co., of Chicago, continuing in their service until May, 1919. He has been well known in the asphalt industry and paving industry for the past 10 years and has a wide acquaintance in the central and south Atlantic states.

Trade Publications

The T. L. Smith Co., Milwaukee, Wis., has issued a 16-page catalog describing its new model H paving mixer.

The American Cement Machine Co., Inc., Keokuk, Ia., has issued a catalog illustrating and describing its new 1920 type Boss steel roller pinion drive mixers.

The Storms Manufacturing Co., Crawfordsville, Ind., has issued a booklet describing its one man collapsible culvert form. The booklet contains a number of letters from users of the forms.

Blawform is the title of a 24-page catalog gotten out by the Blaw-Knox Co., Pittsburgh, Pa. It is devoted to illustrations and descriptions of the use of steel forms in the road and sidewalk construction field.

The Smith Engineering Works, Milwaukee, Wis., has issued three bulletins on rock crushing equipment. One of them deals with Telsmith primary breakers and Telsmith reduction crushers; the second with Telsmith jaw crushers, and the third with mounted gyratory breakers and portable bins. The illustrations show several interesting crusher installations.

Waterworks and Hydraulics Monthly Issue

ENGINEERING AND CONTRACTING

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Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation and Dredging
(b) Rivers and Canals
(c) Quarries and Pits
(d) Railways, Steam and Electric
(e) Management and Office System

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials

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The Remarkable Change in Opinion as to the Persistence of High Prices

When the war ended there was an almost universal expectancy that prices would fall rapidly. Exactly six months have elapsed since the armistice was signed, yet the general price level has scarcely changed. Moreover, most business men and economists have reversed their opinion of six months ago and do not look for any substantial reduction in the present price level for many years to come. Illustrative of this remarkable change in opinion we quote two statements made by officials of the National City Bank of New York, one of which was made in October, 1918, and the other in April, 1919:

"The primary cause of this great rise of wages and prices, of course, is the war. It has taken millions of men from the industries and set up an enormous demand for the war supplies.

"After the war is over there will be a change of all conditions. When the Government orders are finished and paid for, unless a similar volume of equally urgent demands spring up from new sources, the inflation of credit will subside. Bank loans and deposits will decline and the percentage of bank reserves will rise. This would mean a readjustment of values toward the pre-war basis. Evidently the course of this readjustment will be governed by the industrial situation and [illegible] time.

"We may expect that after the war there will be [illegible] demand for many kinds of goods and equipment so urgent that for a time price will be a secondary consideration. The whole world is going without things that it would [illegible], is wearing out equipment and falling behind [illegible]. It is falling behind in house-building, for example, in road-making, in railway extension and in the development and improvement of public utilities. Automobile construction has nearly ceased, and the cars in use will be nearly worn out. Clothing [illegible] the world over [illegible] low, therefore there will be a good market for cotton and our cotton States should be prosperous.

"Nevertheless it is inevitable that prices will be upon a declining scale and this will be the factor of uncertainty and danger in the situation. Falling prices, shrinking values in inventories, stocks of goods, and capital investments, have a depressing influence. It is com- [illegible] money when prices are rising; the most venture- [illegible] successful then. Errors [illegible] good by something out- [illegible] Farmers of even indifferent skill, who could [illegible] ing of profits from their

28 Pages = 40 pages

The 28 pages of articles in Engineering and Contracting contain as many words as 40 pages of the size and typography commonly used by other engineering periodicals. Ours is the same size of type and type-page as that of The Literary Digest—easily read, yet giving a large volume of reading matter per page. Our 28 pages of articles would fill 112 pages of the standard 6x9 in. text-book. It would take 10 such books of 580 pages each to hold all the articles printed each year in Engineering and Contracting, to say nothing of our weekly construction news.

farming operations, have become well-off from the rise of land values. The situation is very different with prices on a declining scale, for then not only is there no margin for higher [illegible] by an unearned difference between buying and selling prices, but a portion of the normal earnings is lost, and as net earnings decline, capital values shrink, credit is unfavorably affected, and indebtedness becomes relatively heavier and more burdensome. Therefore it is in order to give warning against incurring indebtedness, which will reach over into the period after the war, when prices and earnings will be lower than now.

"There is another reason why prices must come down after the war and that is that unless they do the monetary systems of the whole world will have to be reorganized in a manner which will not only do great injustice to all persons who hold a creditor position, but involve business affairs generally in such confusion as will disorganize production and the exchanges and occasion losses to all classes."—Bulletin of the National City Bank, October, 1918.

Contrast the foregoing quotation with the following from a paper read April 11, 1919, by O. P. Austin, statistician of the National City Bank of New York:

"If we are right in assuming that a considerable proportion of the world advance in prices is due to the enormous increase in world currency can we expect a marked reduction in prices until the cause, 'inflation,' is removed? Or, to put it in another form, that part of the advance caused by inflation can only be cured by deflation, by a reduction in the enormous stocks of currency which, as I have shown you, has trebled during the war, while that other form of slowly moving currency, governmental obligations, has quintupled.

"If the governments which have been the chief participants in the world increase of currency should fail to reduce materially that excessive supply, and if the world's demand for food, manufacturing material and manufactures is to continue at the present rate, are we justified in expecting a general reduction in prices in the near future? The question I think answers itself. There will, of course, be instances in which there will be material reductions, but in general terms the outlook for marked or rapid decline, at least in the near future, does not seem encouraging."

Our civil war ended in 1865, yet it was 1878 before the average price level dropped back to about what it was in 1861, and then only after the severe panic of 1873 had caused countless business failures. Contrasted with the recent world war, our civil war was merely a skirmish.

In an article by Halbert P. Gillette, in this issue, it is stated that the 15 leading nations of the world, exclusive of Russia, have tripled their currency and have also tripled their bank deposits since the war began. Those nations have issued 36 billion dollars of paper money in five years, or more than all the gold and silver mined since Columbus discovered America This enormous money inflation necessarily means enormous rise of price levels.

Although it has taken only five years to triple the currency and bank deposits of 15 nations, economists and business men agree that it will take a far longer time to deflate the currency. The same governments that were able to print 36 billion dollars of paper money and issue 180 billion dollars worth of bonds in five years will be unable to retire either the paper currency or the bonds in a generation. Consequently it is idle to expect much of a price fall in Europe for a great many years. Mr. Gillette's article explains why the price level in America will also be very slow in falling.

What Do You Know About the Cost of Trenching With Machinery?

This Waterworks and Hydraulic issue carries more than 70 pages of advertisements. Most of these advertisements are either educational or open the door to information of an educational nature. The catalogs of most manufacturers in this field are no longer mere tables of dimensions, etc., but contain much valuable and suggestive matter, costs, etc.

The editor is just finishing the writing of a new edition of his "Earthwork and Its Cost." The new chapter on trenching will alone contain 150 pages. In the preparation of that chapter the editor was impressed by the excellence of the matter found in the catalogs of manufacturers of trench machines, steam shovels, backfillers, etc. Even the photographs in the catalogs are suggestive of economic ways of digging, bracing and backfilling "ditches."

Now that common labor wages have doubled, every man in charge of trench work, even on a small scale, should study very carefully what can be accomplished with machinery. Not every one seems to realize that as wage rates rise, machinery becomes more economic.

Waterworks superintendents and contractors who have been accustomed to say that machinery can not be profitably used on shallow trenches, had better do a bit of figuring. Interest and depreciation charges on machinery are now of far less relative importance than they were five years ago, whereas wages are of far greater relative importance. Moreover, laborers are less efficient than they were. All of this makes for a much greater use of machinery for trench work even on shallow trenches and on small jobs.

How Waterworks Engineers and Superintendents Can Reduce Pneumonia

The use of chlorine and filtration are the two methods of water purification that have almost eliminated typhoid fever from our cities. By the drainage of swampy places, and the dosing of stagnant waters with oil, malaria and yellow fever have been brought under control. We are now beginning to realize that lung, throat and nose diseases can be largely prevented. Curiously enough the sanitary engineer is called upon to study the use of water to prevent diseases of the respiratory organs, much as he had to study the treatment of water to prevent intestinal diseases and malaria.

Influenza, pneumonia and tuberculosis have long been the three major "plagues," with pneumonia in the van of deadliness, if deadliness is estimated by the number of deaths. Pneumonia is a bacterial disease that is mainly spread by air-borne dust particles on which the microbes ride into the nostrils of their victims. Remove the dust, and the microbes that cause pneumonia are also removed. If this fact were generally known, and its significance fully appreciated, every city and village would demand dustless streets. This would necessitate frequent flushing of all streets with water, for flushing is the most effective means of removing street dust.

How many waterworks superintendents realize that it is their duty to preach the liberal use of water for washing pavements? Very few, we fear, for never yet have we seen an annual report of a waterworks superintendent in which there was even a paragraph preachment on this subject.

Listen to what Dr. Rufus Cole of the Rockefeller Institute, recently said in an article on "Pneumonia, as a Public Health Problem":

"Pneumonia is really a public health problem, but it has not been so recognized until recently. It took the insight of Dr. Hermann M. Biggs to see that pneumonia might be prevented, and that the high mortality from this disease might possibly be reduced. Pneumonia causes more deaths in this country than any other of the communicable diseases. It is responsible each year for over 100,000 deaths in the United States, and for over 10,000 deaths annually in New York City alone. . . .

"Pasteur said that any bacterial disease is theoretically preventable when we know the means by which the organisms causing it gain entrance to the body. . . .

"The place where the infectious organisms are most concentrated is in the respiratory tract of the patient. That is where we can attack them most successfully. It is important in the first place to prevent the infection spreading from the individual sick with the disease. This can be done, first, by isolation of the patient. This means that we must recognize that these respiratory diseases are communicable.

"Second, we can prevent the spread of the infection by cleanliness in the surroundings of the patient. It has long been known that the organisms causing pneumonia may exist for a considerable time in dust. They are spread from the patient sick of pneumonia to the dust around him, and this dust is most infectious. By preventing the spread of this dust undoubtedly much can be done. The question of dust infection has not been given sufficient attention by those engaged in public health work. For years Dr. Prudden has been impressing upon us the dangers of dust [illegible] we have been so interested in better water supplies, better sewerage systems, etc., that we have forgotten the importance of dust in spreading infection, especially in spreading the acute respiratory diseases, which now cause more deaths than all the other acute communicable diseases combined."

"It is possible that by the use of gauze masks much can be accomplished in preventing the transmission of infection from the mouths of persons sick with the disease."

Our readers should take particular note of what Dr. Cole says about the "importance of dust in spreading infection," for, aside from what doctors can do to prevent disease, there is no class of men who can accomplish as much along that line as can the class who read this Waterworks and Hydraulic Monthly issue of Engineering and Contracting. It is we engineers and waterworks superintendents whom the public should thank the most for having so greatly reduced the typhoid death rate. Now let us take the next great step by securing for the public streets as clean as a hospital floor. Let us not rest until we secure appropriations with which to flush every business street every day, and every residence street at least twice a week. Let us put an end to the clouds of dust that are worse than the hosts of the Huns in spreading death and misery among men.

Would You Employ a Three Thousand Dollar Superintendent in a Ten-Million Dollar Plant?

If you owned a ten-million dollar plant having an annual gross revenue of a million dollars, what would you think of yourself if you paid the superintendent of your plant only $3,000 a year? Pretty small peanuts, you would be, wouldn't you? The city of Milwaukee is just that size peanut, for the city waterworks is a ten-million dollar plant, and its superintendent receives only $250 a month, or about the pay of one of Ford's skilled mechanics.

Milwaukee is inclined to be socialistic; and socialist aldermen, having themselves rarely earned $250 a month, are inclined to think that no man is worth that much. Although Milwaukee is perhaps the worst of the large cities in respect of low municipal salaries, many another large city is not much better. In fact, no city, large or small, is paying adequate salaries to its waterworks superintendents and city engineers.

When will municipalities see that the men who design and manage their plants should be liberally paid? Not until salary-fixing officials are themselves men who have occupied private positions yielding large incomes. That probably means not until the commission-manager form of city government is adopted, and not even then unless the public press persuades the voters to elect commissioners who have shown first-class executive ability in the conduct of their own business or professional work. Such men know from experience that it is always good business to pay liberal salaries to executives in responsible positions. Often they do not realize that it is equally good policy to pay designing engineers liberally, but it is generally not difficult to persuade a man who has himself earned a large income that the best of designing skill is secured when designers are liberally paid, and usually not otherwise.

The Increased Cost of Farming

Although every producer knows that his own costs of production have risen enormously, each man is apt to think that he is being overcharged by the men from whom he buys. Especially are we all inclined to regard the present prices of foods as being "little short of robbery."

Farmers are now beginning to publish cost data that give us a different idea as to the prospect of paying prewar prices. Recently the International Farm Congress at Kansas City issued a report in which was given the present and the prewar costs of producing wheat, based on the records of several hundred farmers in Kansas, Oklahoma, Nebraska and Missouri. We quote:

[illegible]

Less value of pasturage and straw............

[illegible]

Note that while this shows a rise of 50 per cent in the cost [illegible] or interest on the land, as contrasted with a 50 per cent rise [illegible]

The prices of farm lands are rising so rapidly that it seems unlikely that the average price of farm products will decrease very much for many years. Freight rates have gone up 25 per cent since 1914 and will have to be raised another 15 per cent. Hence, we may confidently look for a market price of farm products fully 60 per cent in excess of that in 1914, even should there come a very decided reduction in the present demand for food stuffs.

Book Reviews

[illegible]

This volume is a logical revision and enlargement of "Irrigation Engineering" by Wilson, which was first published in [illegible] long been recognized as a standard.

The subject matter has been drawn largely from the author's personal contact with large irrigation works both here [illegible] factors influencing the design of a reclamation project. These include the discussion of irrigable soils, water supply, evaporation, pumping, and the application of the water to the land with a description of devices used for the measurement of irrigation water. Experiments by the U. S. Department of Agriculture and others have added substantially to the knowledge which pertains to crop production on irrigable lands. The values are well tabulated and discussed.

The rest of the book is mainly devoted to the methods of design and construction of irrigation works and appurtenances. The design of canals and laterals, and canal structures is taken up in considerable detail. A new formula for seepage from canals is advocated. It is proposed as representing the results of existing data taken from many years of observations.

The design of various types of dams is covered quite completely. The author has drawn liberally from his own observations to assist one in the design and construction of reservoirs, earthen and masonry dams. That departure from the theoretical design of dams in certain instances is permissible is upheld by the experience of the author.

The book is well illustrated with photographs and details of a great number of existing works both here and abroad. Each chapter is followed by a bibliography.

While considerable matter has been taken from the previous editions, the amount of new matter presented recommends it as a very desirable new book.

[illegible]

Exceedingly interesting from the viewpoint of the technical reader and valuable because of the data contained in this volume on water chlorination. Information hitherto scattered in various journals and treatises is collected and correlated in a comprehensible manner.

The dosage of chlorine required for the treatment of a water is fully discussed.

The chapter on complaints from consumers of chlorinated water will interest every waterworks operator, because of the numerous experiments noted which tend to disprove popular claim to the deleterious effects of water thus treated. Laboratory methods for the control of hypochlorite plants are given. The electrolytic method for the production of chlorine is described. The cost of this method as compared with the cost of liquid chlorine is shown.

The information gained from extensive experiments has enabled the author to present a great deal of data on the subject of chloramine. The operation of the Ottawa chloramine plant is stated to have effected a considerable saving over the use of bleach. Some recent facts on the sterilization of water for the use of troops in the field are pertinent.

The last chapter is devoted to the results obtained from the chlorination of water. The words of caution to the misusers of the process are timely.

The bibliography at the close of each chapter is a commendable feature.

Bidding Prices in 1915 and 1919 on Gravity Water Supply System

To the Editor: I am enclosing some prices bid June 2 at Newark, N. Y., which if published in your journal would, I think, help materially in leading other communities to start such construction work for this year as they have under consideration.

The prices submitted at Newark were for a gravity water supply system which will cost in the neighborhood of $300,000. The prices bid for pipe are the lowest that the writer has seen this year. For purposes of comparison I append a table of prices for a similar gravity system for which bids were received almost exactly four years ago. The two systems are almost identical. The Newark dam will be constructed practically under the same conditions as the dam at Le Roy. The price for core-wall concrete in both cases is particularly low. This is due to the fact that gravel is available at the site of the dam. The Le Roy pipe line was almost entirely excavated with a trenching machine and it will also be possible to use a machine for a greater part of the distance on the Newark line. The filter plant at Le Roy and the one proposed for Newark will be practically the same.

The writer prepared both the plans for the Le Roy and the Newark systems and the bids received at Le Roy were within the estimates. As the bids received at Newark June 2nd are well within the writer's estimates it is the intention of the Board to immediately award the contracts.

JAS. P. WELLS,
Consulting Engineer.

Rochester, N. Y.

PRICES ON GRAVITY WATER SUPPLY SYSTEM AT LE ROY, N. Y., IN 1915, AND AT NEWARK, N. Y., JUNE 2, 1919

DIVISION 1—EARTHEN DAM AND DYKES

Unit Prices of four low bidders at NEWARK, N. Y. — Unit Prices for Contract awarded to Morrison & Quinn for work at LE ROY, N. Y.

[illegible] & [illegible]	Brown, Lowe & Law Bros.	Foundation Co.	E. W. Foley Co.	Quantities Newark.	Unit of Measurement.	Items	Quantities Le Roy.	Unit Price.
						Clearing and grubbing	(lump sum)	
$ [illegible]	$ 1.00	$ 1.25	$ 1.50	2,300	cu. yd.	Earth excavation, core wall and pipe trenches	1,300	$ .55
1.00	.80	.55	.95	28,600	cu. yd.	Earth embankment in dam and dikes	23,300	[illegible]
1.35	1.00	1.40	1.50	1,200	sq. yd.	Riprap	1,100	.40
[illegible]	1.50	[illegible]	1.50	100	sq. yd.	Cobble cutter	.....	.....
12.90	14.00	[illegible]	14.00	200	cu. yd.	Class "A" concrete	.....	.....
[illegible]	12.00	20.50	16.00	175	cu. yd.	Class "B" concrete	300	[illegible]
[illegible]	11.00	11.50	8.50	2,450	cu. yd.	Class "C" concrete	1,600	[illegible]
[illegible]	.80	.60	1.56	300	lin. ft.	Laying 14-in. cast iron pipe	300	.65
6.00	25.00	13.00	10.00	4	each	Valves, 14 in., hauling and setting in place	.....	.....
12.00	25.00	13.00	15.00	6	each	14-in. flanged special castings, hauling and setting in place	.....	.....
12.00	10.00	13.00	25.00	1	each	Setting valve stem and wheel	.....	.....
.20	.10	.16	.10	1,200	lb.	Miscellaneous, steel ladder, reinforcing steel, etc.	500	.07
1.20	2.50	.60	1.50	[illegible]	lin. ft.	10-in. vitrified tile pipe furnished in place	.....	.....
.90	.80	.20	1.00	50	lin. ft.	4-in. vitrified tile pipe furnished in place	.....	.....
25.00	15.00	18.50	40.00	1	each	Wooden rack, furnished in place	2	9.60
12.00	20.00	13.50	20.00	1	each	Hauling and setting 14-in. fish trap	1	6.50
$66,917.50	$68,425.00	$69,067.00	$70,880.00			Totals		$20,552.[illegible]

DIVISION 2—1,000,000 GAL. MECHANICAL FILTRATION PLANT

Five low bidders at Newark, N. Y.: Norwood Engineering Co., $24,960; Roberts Filter Mfg. Co., $31,613; Hydro Construction Co., $[illegible]; Pittsburgh Filter Co., $32,500; Foundation Co., $37,500. The contract for the Le Roy plant was awarded to Norwood Engineering Co. on lump sum bid of $12,800.

DIVISION 3—LAYING CAST IRON PIPE.

Unit prices of four low bidders at NEWARK, N. Y. — (Bell and Spigot Pipe.) — Unit prices for Contract awarded to Chas. Shepard for work at LE ROY, N. Y.

J. F. Leary Const. Co.	Foundation Co.	Bruno Pizzementi.	Tifft. Const. Co.	Quantities Newark	Unit of Measurement.	Items	Quantities.	Unit Price.
$ [illegible]	$ .88	$ [illegible]	$ 1.10	38,350	lin. ft.	Hauling and laying 14-in. cast iron pipe	24,500	$ .47
.50	.80	.30	.90	120	lin. ft.	Hauling and laying 6-in. cast iron pipe	100	.50
20.00	13.00	25.00	15.00	6	each	Hauling and setting 14-in. valves	5	19.00
15.00	13.00	10.00	10.00	5	each	Hauling and setting 6-in. valves	2	5.60
[illegible]	2.65	5.00	5.00	5	each	Hauling and setting 1-in. air valves	6	5.60
10.00	10.70	25.00	10.00	400	feet	Creek crossing	.....	.....
$31,125.00	$38,280.25	$44,428.50	$46,458.00			Total or gross sum of bid.		

(Universal Pipe.) (Alternate.)

Foundation Co.	J. F. Leary Const. Co.	Bruno Pizzementi	Tifft. Const. Co.			
$ .52	$ .70	$ .70	$ .95	38,350	lin. ft.	Hauling and laying 14-in. cast iron pipe
.70	.50	.50	.80	120	lin. ft.	Hauling and laying 6-in. cast iron pipe
13.00	20.00	25.00	15.00	6	each	Hauling and setting 14-in. valves
13.00	15.00	10.00	10.00	5	each	Hauling and setting 6-in. valves
3.65	5.00	5.00	5.00	5	each	Hauling and setting 1-in. air valves
10.70	10.00	25.00	10.00	400	lin. ft.	Creek crossing
$24,474.25	$31,125.00	$37,130.00	$40,693.50			Total or gross sum of bid

DIVISION 4—FURNISHING CAST IRON PIPE.

Unit prices of four low bidders at NEWARK, N. Y. — (Hub and Spigot Pipe.) — Unit prices for Contract awarded to U. S. C. I. Pipe & Foundry Co. for work at LE ROY, N. Y.

U. S. C. I. Pipe & Fdry. Co.	Warren Fdry. & Mach. Co.	Central Iron Works	J. Fox & Co.	Quantities. Newark.	Unit of items measurement.	Items	Quantities.	Unit price.
$ 48.40	$ [illegible]	$ 51.10	$ 51.80	200	tons	14-in. Class "B" cast iron pipe	564	$ 23.70
49.40	50.50	[illegible]	[illegible]	1,550	tons	14-in. Class "A" cast iron pipe	605	23.70
49.40	54.60	51.60	52.70	2	tons	6-in. Class "A" cast iron pipe	2	23.70
[illegible]	[illegible]	[illegible]	[illegible]	1,600	lb.	Flanged special castings		
[illegible]	[illegible]	[illegible]	[illegible]	6,000	lb.	Bell and spigot special castings	8,000	[illegible]
110.00	110.00	50.00	55.00	1	each	14-in. flanged fish trap	.....	.....
$86,908.80	$88,873.00	$90,832.20	$92,670.90			Total or gross sum of bid.		

(Universal Pipe.)

Central Foundry Co.

	Quantities.	Unit Price
$ 3.00	38,350 ft.	14 in. universal cast iron pipe
1.00	120 ft.	6 in. universal cast iron pipe
.07	1,600 lb.	Flanged special castings
[illegible]	[illegible] lb.	Universal special castings
65.00	1 each	14-in. flanged fish trap
$115,707.00		Total or gross sum of bid.

Will Present High Prices Persist?

By HALBERT P. GILLETTE,

Editor Engineering and Contracting

According to Lord d'Abernon, a British economist, money has been depreciating for 700 years, but its fall during the world war was greater than during the two centuries from 1700 to 1900, and equal to that during the four centuries from 1300 to 1700. Although the persisting tendency of money to decrease in buying power is a phenomenon of great political importance, the average man is far more interested in the question that heads this article: "Will present high prices persist?"

Every prolonged war has led to a rise of prices and wages, but in nearly every case there has been a subsequent fall in prices and wages, usually, however, at a comparatively slow rate. Why is it that prices rise suddenly during a war, but recede slowly? Prices rise rapidly during a war because of the sudden increment in demand for many classes of products. But why does not an equally rapid fall in prices occur when the demand for those very articles falls off suddenly at the end of the war? The answer is found in two facts, one of which is psychological and the other of which is material. The material fact is the great increase in money and money equivalents. The psychological fact is that most of the increment in money is in the hands of people who are habituated to spend nearly all that they earn. Let us consider each of these factors.

From the time that Columbus discovered America up to the present day about 17 billion dollars worth of gold were mined, but only a little more than half of this (9 billions) exists today in coins or bullion. During the world war, the fifteen leading nations engaged in the war, excepting Russia, issued 36 billion dollars worth of paper money, which is more than all the gold and silver dug from all the veins and placers in the world during the last four centuries! This inevitably caused a great depreciation of money in Europe, price of commodities often rising several fold. In France prices now average three and a third times what they were before the war, while in England they are two and a third times what they were. In America prices have slightly more than doubled, as shown by Dunn's index, as the average price of more than 300 commodities.

It is easy to see why prices have risen greatly in countries that have issued large quantities of paper money, but why has the rise been so great even in America where government printing presses have not been busy turning out paper dollars? The answer is to be found largely in the fact that gold money and bullion have flowed from Europe to America in such volume that we now have more than three billion dollars worth, whereas we had but two billion dollars worth before the war. In short, America now holds one-third of all the gold in the world.

Practically all our gold is held by our government and by the banks as "reserves" upon which are based the issue of paper money and that form of credit money known as bank deposits. The ratio of bank deposits to gold in America has averaged about 9 to 1 during the past ten years, as shown in the following table:

Year.	Gold.	Bank Deposits.
1910	............1.7 billions	15.2 billions
1913	............1.9 billions	18.0 billions
1914	............1.8 billions	19.0 billions
1915	............2.3 billions	19.5 billions
1917	............3.1 billions	26.3 billions

While it is true that the "credit money" that exists in the form of bank deposits may shrink, and shrink rapidly, either because banks call loans or because business men and investors voluntarily curtail their borrowings, it is noticeable that even great panics have not caused much reduction in bank deposits in America. We need not enter into a discussion of the reasons for the relative stability of the rates of bank deposits to gold, but we should note the significance of the enormous increase in our bank deposits since 1913. This increase in credit money has kept pace with the increase in gold, and it is available for use.

The extent to which this credit money is used is measured by the bank clearings, for they register the volume of "turn over" of money from one individual or corporation to another. During no year for the past 20 years have total annual bank clearings in America been more than 13 times the average deposits (and that was in 1915), and for no year have annual bank clearings exceeded 13 times the bank deposits. The normal ratio has been about 12 to 1, which was the ratio in 1916 and 1917.

Bank deposits have averaged about 9 times the gold, and the monthly bank clearings have normally been equal to the bank deposits in America. Our credit money, therefore, moves with great and almost uniform rapidity in normal times. In abnormal times, such as war times, a temporary decrease in rapidity of circulation of money may occur, such as occurred in the latter part of 1914 and the fore part of 1915. But prices do not fall appreciably unless such curtailment is prolonged.

Since the end of the war bank clearings have been normal and have slowly been increasing. This itself spells the maintenance of high prices, if it persists, but will it persist?

That our gold supply will not decrease greatly for many years is evident. Balances of trade long have been in our favor and seem likely to remain so. Europe owes America about 10 billion dollars, even the interest on which can not be paid in gold. Emigrants from America to Europe are consequently able to secure no gold from our banks. And for the same reason, even tourists who go to Europe will not be permitted to take gold.

With no probability that our gold supply will decrease for many years, there is assurance that our credit money (bank deposits) will not decrease; and, if so, the average price level will not fall unless a general financial scare leads to prolonged curtailment of expenditures by many people. Now it so happens that the class of men who are most timid about investments, namely, men of wealth, are the very ones who have largely converted their bank balances into government bonds. Moreover, these are the men whose normal savings for investment purposes have been largely taken from them by income taxes. On the other hand, the class of people accustomed to spend nearly all that they earn as fast as they earn it have received, and will continue to receive, most of the money paid to Uncle Sam by wealthy men. This introduces a psychological factor that has been generally ignored both by business men and by writers on economics.

Although a per capita increase of 50 per cent in currency and in bank deposits does not of itself insure a corresponding rise in the average price level, such an increase does result in at least an equal increase in prices if nothing occurs to intimidate buyers in general. Wage and small salary earners are not easily intimidated. In fact, they are apt to be reckless spenders at all times. That they are spending to the limit right now is shown by the unprecedented sales of all merchandising companies that publish financial reports. New capital is not yet flowing in normal volume into new buildings and plants, but that capital is moving with normal velocity is shown by the volume of bank clearings. This is primarily due to the desire of the average wage earner to spend almost his entire income. Since that desire is habitual in America and since the war has increased the income of the spending classes at the expense of the saving classes, there is no likelihood that bank clearances will decrease: and, if not, prices in general will remain high, because our volume of gold and of bank deposits has increased greatly during the war.

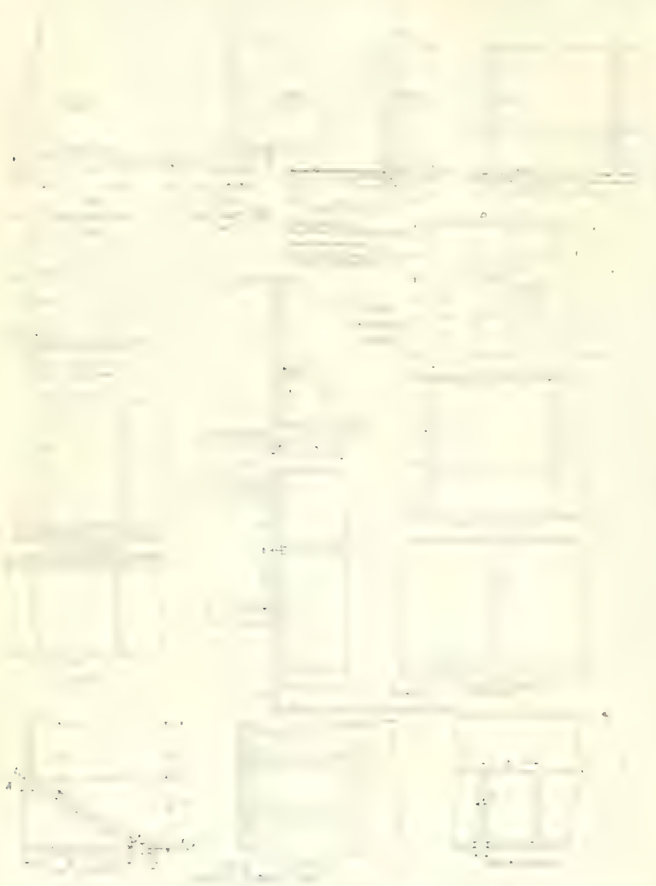
Summing up, we have a 50 per cent increase of gold, upon which has been built a 50 per cent increase in bank deposits, from which has resulted somewhat more than a 50 per cent increase in bank clearings, or money turn over—all during the [illegible] period—with no prospect of decrease in the rate of turn [illegible] forced through taxation [illegible] most of their current savings to the habitual [illegible]

[illegible] rapidly, but there is not a quick reversion to the prewar condition after the war ends, if a considerable amount of money has been created. The 15 leading nations of the world, excluding Russia, have tripled their money during the war by the issue of paper money, and they have also tripled their bank deposits or credit money. None of them will be in any hurry to retire the paper money, for that would put them at a disadvantage in paying off their huge debts. Hence, the enormous inflation in money, with its corresponding price inflation, although it occurred in the short period of five years, will not be reduced in several times five years. High prices and high wages will persist for many years.

Economies of Reinforced Concrete Walls for Uncovered Reservoirs

By H. E. BABBITT,
Associate Professor Municipal and Sanitary Engineering
University of Illinois

In the design of a reinforced concrete wall for an uncovered reservoir the choice of the type of wall is dependent mainly upon economy. The determination of the most economical wall for any particular conditions can be made by designing walls of various types to fulfill the conditions and making a detailed estimate of cost from these designs. Such designs have been made for walls varying in height from 5 to 30 ft., either with or without earth backing. The types of walls studied are shown in Figs. I to VI inclusive. The least volume of concrete per foot of length of these walls for different heights is shown in Figs. VII and VIII. The relative economy of the different types of walls is indicated by the relative amount of concrete in the different types. The difference in the volume of concrete and therefore the economy of the "special" type of wall, compared with the cantilever wall is striking.


Figs. 1-6—Types of Wall Studied to Determine Most Economical Design.

Although the cost of reinforced concrete walls is not directly proportional to the volume of concrete, for any two walls of the same height and with the same loading, the relative cost is approximately as the volume of concrete. The amount of steel is approximately proportional to the volume of the wall. The cost of the form work is dependent more on the type of wall than upon the volume of concrete. Since the amount of form work on the "special" wall is somewhat greater than for the cantilever wall, the apparent saving by the use of the "special" type is somewhat reduced, but the relative economies of the different types of walls is unaffected.

These designs were based on a factor of safety against overturning of 2. The working strength of steel was taken as 16,000 lb. per square inch, and of concrete as 650 lb. per square inch. No section less than 8 in. thick was used. The greatest intensity of foundation pressure was 6,000 lb. per square foot. The "active" earth backing was assumed to act as a liquid weighing 20 lb. per cubic foot. Although these assumptions may not be in accord with all conditions of design, a difference in the unit stresses, thicknesses, etc., will affect all types of wall alike and will not affect the relative economy as shown in Figs. VII and VIII.

In making the designs of these walls the relative economy of various details were developed. In the cantilever wall the economical length of the footing is shown in Fig. IX. For the buttress walls, the economical buttress spacing, the best details of the buttresses, and the effect on the volume of the wall by a change in the buttress spacing are shown in Figs. X and XI. Similar details are shown for the other types of walls in Figs. XII to XV.

In determining the volume of concrete in the walls the resisting moment against overturning of all portions of the wall was expressed in terms of as few unknown dimensions as possible. The resisting moment was equated to twice the overturning moment. When it was not possible to express the resisting moment in tems of only one dimension, all but one dimension were assumed and the unknown dimension solved from the equation. With all dimensions known the determination of the volume of the wall was a matter of solid geometry. New values of the assumed dimensions were tried until the least volume of concrete for the given height of the wall was found. It was in the process of such computations that the economical dimensions of the various details were found.

The expressions for the dimensions of various portions of the walls were determined either analytically or by trial in

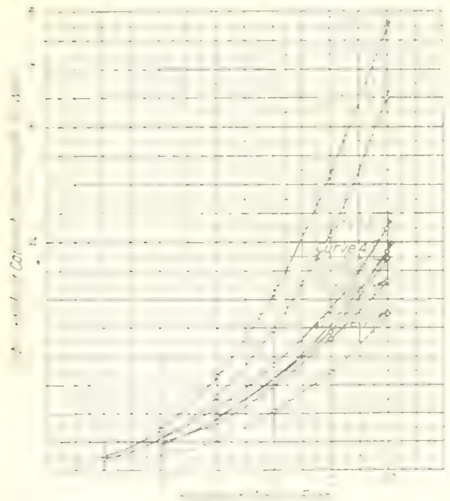


Fig 7

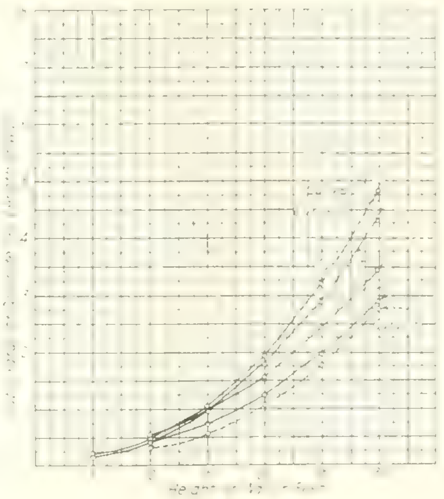


Fig 8

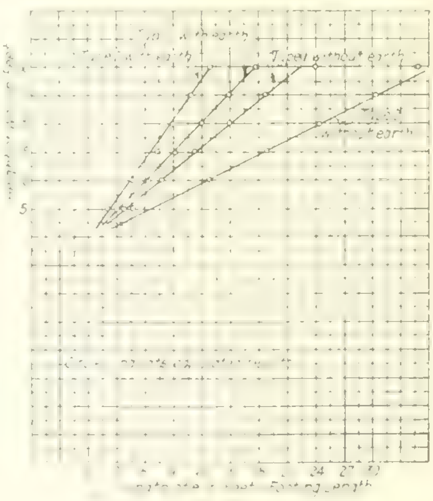


Fig 9

Fig. 7—Amount of Concrete in Different Types of Walls Without Earth Backing: Curve 1, Cantilever Wall, Type 2; Curve 2, Cantilever Wall, Type 1; Curve 3, Counterfort Wall; Curve 4, Buttress Wall; Curve 5, Buttress and Counterfort Wall; Curve 4, Buttress Wall; Curve 7, Special Type of Wall Minus the Quantity of Concrete in a Floor 0.67 Ft. Thick and the Same Width as the Base of the Wall. **Fig. 8—Amount of Concrete in Different Types of Walls With Earth Backing:** Curve 1, Cantilever Wall, Type 1; Curve 2, Cantilever Wall, Type 2; Curve 3, Counterfort Wall; Curve 4, Buttress Wall; Curve 5, Special Type of Wall Without Earth Backing Minus the Quantity of Concrete in a Floor 0.67 Ft. Thick and the Same Width as the Base of the Wall. **Fig. 9—Footing Lengths for Cantilever Walls: Circles Indicate Calculated Results.**

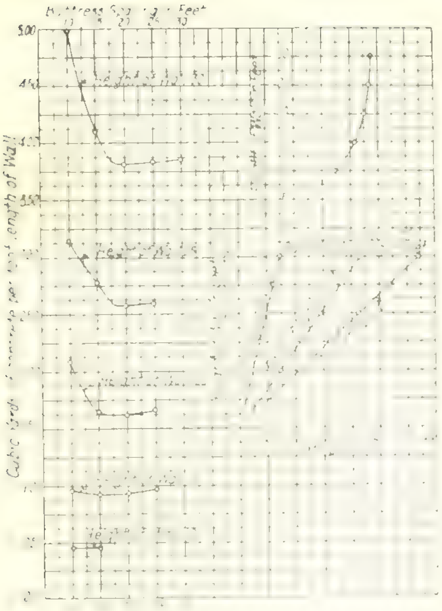


Fig 10

Fig. 10—Economies of Details of Buttress Walls Without Earth Backing.

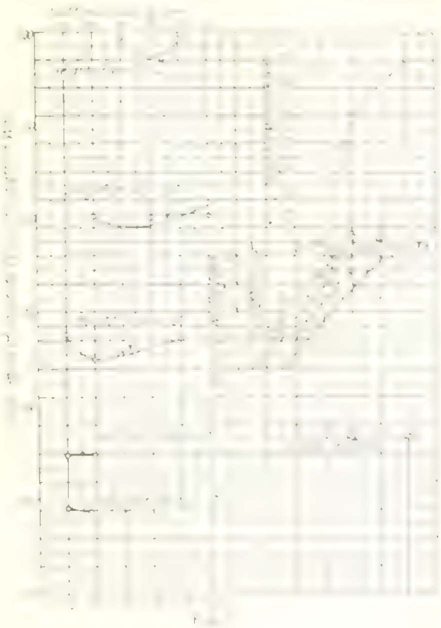


Fig. 11—Economies of Details of Buttress Walls With Earth Backing.

Fig. 12—Economies of Details of Counterfort Walls Without Earth Backing.

such a manner as to make possible the expression of the resisting moment in but few unknown terms. For certain details the economical dimension is that dimension which will give the least amount of material commensurate with the load which is to be supported. In other details the economical dimension is not a function of the load. Those dimensions which depend almost directly on the load were determined analytically, whereas those dimensions which are

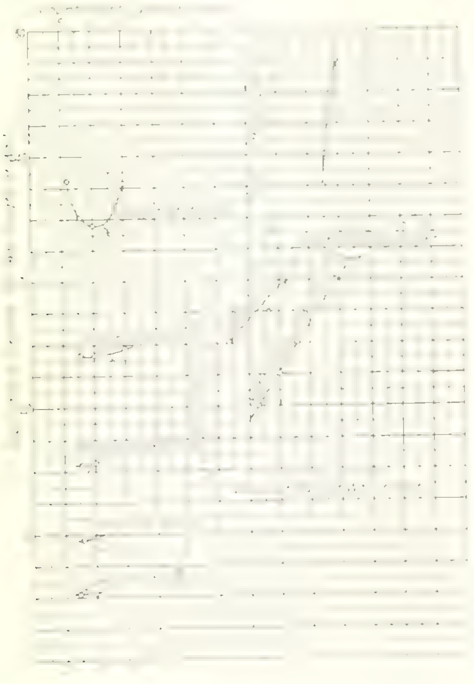


Fig. 13—Economies of Details of Counterfort Walls With Earth Backing.

not direct functions of the load were determined by a method of trial. The following is a summary of the formulas for the details of all of the walls. In addition to the notation on the figures the ordinary notation used in reinforced concrete has been used except that S'_1 represents the effective depth of a beam and S_1 represents the actual depth.

Cantilever Walls, Types 1 and 2, With or Without [illegible]

Figs. 1 and 2.

$$S_1=\frac{M^{\frac{1}{2}}}{100}$$

[illegible]

[illegible] (9)

$10\,h_1$

[illegible]

$\frac{18S_1}{h_1 l}$ [illegible]

Fig. 14—Economies of Details of Buttress and Counterfort Walls Without Earth Backing.

[illegible]

Heights of Walls Between 15 and 30 Ft. High.

[illegible] (8)

[illegible] (10)

[illegible] (11)

[illegible]

[illegible] (15)

[illegible] .(16)

[illegible] . (9)

[illegible]

[illegible]

[illegible] Type without earth backing, Fig. [illegible]

[illegible] same as Equation [illegible]

[illegible] same as Equations [illegible] and [illegible]

[illegible]

[illegible] Wall with earth backing, Fig. [illegible]

[illegible] same as Equation [illegible]

[illegible] same as Equations [illegible] and [illegible]

[illegible] same as Equation 18

[illegible] same as Equation [illegible]

[illegible] Wall without earth backing, Fig. 5

[illegible] .(20)

[illegible] Fig. [illegible]

t_1 = same as Equation 9.

t_2 = same as Equation [illegible]

h_1 = same as Equation 18

$$[illegible] = \frac{h_1 + 6}{[illegible]} \quad (21)$$

Second Type of Wall without earth backing, Fig. 6

$$S_1 = \frac{t_1}{31} \quad (25)$$

[illegible] (26)

[illegible] (27)

$t_1 = 0.67$ ....(28)

t_2 and t_3 determined graphically from Fig. 16

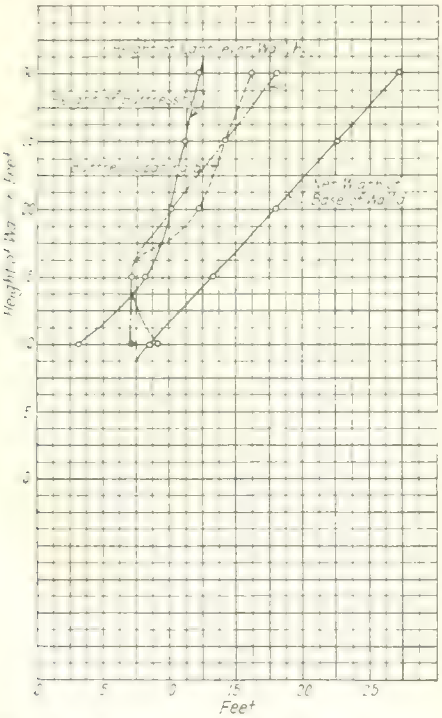


Fig. 15—Economies of Details of Special Type of Wall Without Earth Backing.

The analytical expressions taken together with the graphical representations show the economical dimensions of every portion of the types of wall studied. The results show that for a wall with earth backing a buttress type is the cheapest unless the gain of the floor by the use of the "special" type is taken into account. For walls without earth backing the "special" type is the most economical, regardless of considerations of the saving in the floor area.

Sanitary Regulations for the Protection of New York Water Supply

Disposal of polluting matter on or about the reservoirs furnishing the water supply for New York City is limited, according to the following general rules.

On reservoirs, boating and fishing are allowed under permit.

Within 50 ft. no manner of disposal of human excreta, except water-flushed toilets connected by water-tight pipes to sewage-disposal systems approved by the department, are allowed. All other animal, vegetable, factory or business waste must be adequately purified.

Beyond 50 ft. and up to 80 ft. cesspools, vaults or other receptacles (e. g. pan closets) must be water-tight and fly-proof. Dead animals, garbage, manure, etc., may be buried in the ground.

Beyond 80 ft. cesspools may be leaching.

Beyond 130 ft. individual excreta may be deposited on the ground. Interment may take place.

Beyond 250 ft. ultimate disposal may be made of human excreta from toilets, cesspools, etc., preferably by shallow trenches.

Beyond 300 ft. interment may take place in the case of reservoirs delivering water direct to aqueducts or pipe-lines to New York City.

Beyond ½ mile new cemeteries are permitted on Long Island.

The foregoing note is abstracted from a paper in a recent issue of Municipal Engineers' Journal of New York City.

Cost of Chemicals for Treatment of Water at Council Bluffs, Ia. The water of Council Bluffs, Ia., is clarified by sedimentation, and lime and alum coagulants, and is sterilized by liquid chlorine. The average cost of chemicals for this treatment in 1918 was $1.06 per 1,000,000 gal. An average of 1.6 grains of alum per gallon of water was used; hydrated lime averaged 0.7 grains per gallon; and liquid chlorine averaged 0.258 parts per 1,000,000 gal., or 34.5 oz. per 1,000,000 gal. The average cost per 1,000 lb. of alum, including freight, was $13.10, and for lime, $7.45. The average cost of 1 lb. of chlorine, including freight, was $0.15.

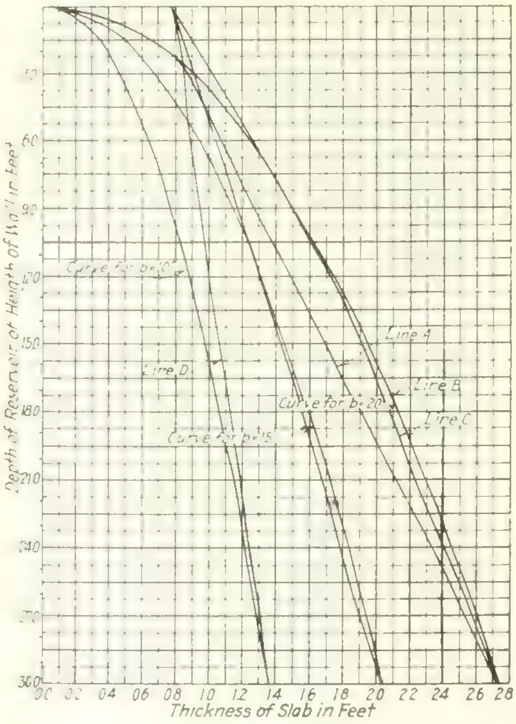


Fig. 16—Graphical Solution of Slab Thickness for Special Type of Wall.

Curves Represent Correct Thickness of Slab in Accordance With the Expression, [illegible] Straight Lines Represent Approximate Solutions as Used.

Effect of Meterage in Oak Park, Ill., and Methods of Controlling Water Waste

For the past 5 years the Water Department of Oak Park, Ill., has made an intensive study of water consumption with a view of reducing the waste to a minimum, and consequently reducing the quantity of water purchased from Chicago. The methods of making this study and the results obtained were outlined by Mr. Herbert P. Matte, Chief Sanitary Engineer of the Illinois State Department of Public Health in a paper presented before the Western Society of Engineers. The matter following is abstracted from the paper.

The city is, and always has been 100 per cent metered, and it has been found that without meters a further material reduction in needless waste would have been an impossibility. In 1913, according to the accepted standards, the Oak Park per capita consumption of 75 gal. was very low indeed. The night rate of consumption for the total system, however, was 58 per cent of the average daily consumption, while 20 per cent seemed to be a fair ratio for a city composed principally of high-class residences with few industries.

As a result of the waste campaign the daily per capita consumption of Oak Park has decreased from 75 gal. in 1913 to 65 gal. in 1918. Yet who can say that Oak Park is not one of the most sanitary cities in the State of Illinois—if not in the whole country?

There are no privies in this city, every house being connected with the sewers. All the consumers have the benefit of water-closets, 95 per cent have bathtubs; and the bathroom consumes about three-fifths of the water used for domestic purposes. Moreover, every building has a lawn, every street has a grassed parkway on each side of the roadway. From inspection of records of sanitary surveys in various cities with lower and even greater per capita consumption than Oak Park, it was found that the number of premises not connected with the sewers varied between 20 per cent and 80 per cent of the total. Every home in Oak Park is connected with the water supply and there are no active wells except two deep wells used by a gas company as a supplement to the city water, and consuming 1 gal. per capita. In other cities of which we have record the wells number 5 per cent to 81 per cent of the total number of buildings.

From the foregoing it follows that Oak Park people should use more water than the average city regardless of relatively small industrial use, because in many cities with industrial plants the big users have access to river, lake or well supply and use the city water only for emergency use or for drinking water.

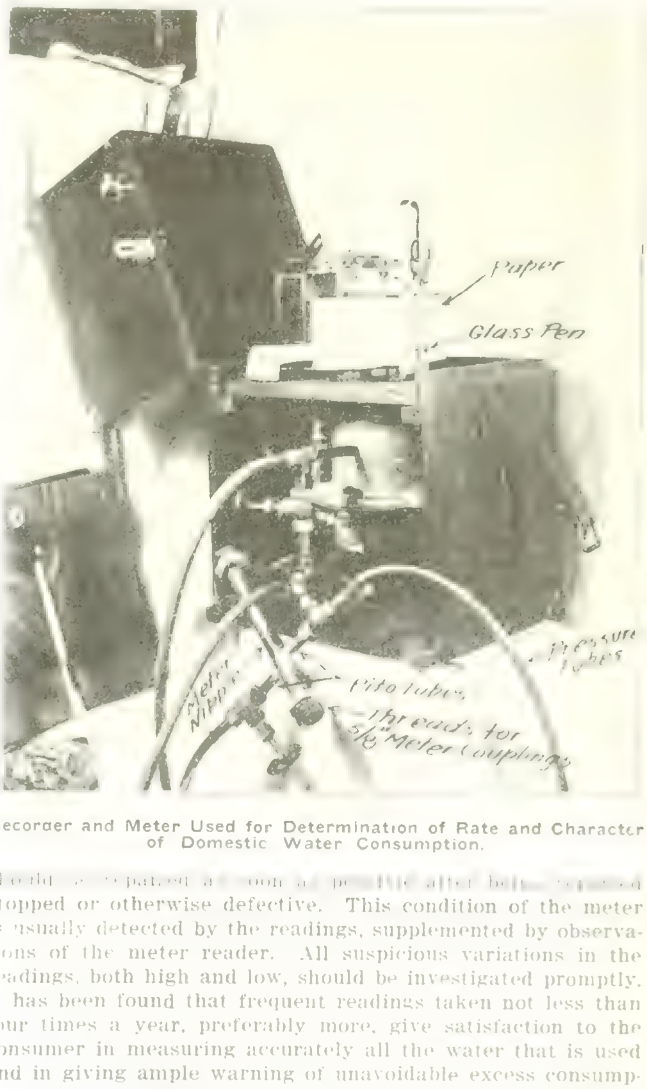
Elements of the Waste Problem.—It will be noted that the night rate of pumpage will often be from 80 to 90 per cent of the average daily consumption. This is indicative of much waste. Too much consumption is generally assumed for industrial and other night uses. Such should be determined, not estimated. In Oak Park the night rate, which is considered the waste barometer, was reduced from 56 per cent to 21 per cent of the average daily consumption in the 4 years between 1914 and 1918, inclusive.

The waste problem was attacked along various lines, some of which are not commonly associated with water consumption. The elements substantially affecting waste elimination as developed in the 4 years between 1914 and 1918 were:

1. 100 per cent meterage.
2. Efficient maintenance of meters.
3. Efficient complaining bureau, including education of consumers in cause and remedy of needless waste.
4. Strict collection of high bills due to leakage or waste.
5. Periodical waste surveys.
6. Comprehensive and workable water ordinance, or rules and regulations, with their strict observance.
7. Centralized control of the water department.

Meterage.—With regard to the first item, 100 per cent meterage, this means that all water pumped or otherwise delivered into the system is measured at the distributing point no matter where located. Included among the services metered are all municipal buildings, watering troughs, drinking fountains, street sprinkling, water used in parks, water used in the construction of houses and all dwellings regardless of size or character; together with fire hydrants when used for other than fire purposes. It is admitted that in the construction of buildings and in the case of fire hydrants that sometimes more water is wasted than is measured, but it was found that the [illegible] of the meter has a great weight in minimizing the unlawful use of water. It is, in fact, a visible permit. Selective metering has been proposed and widely adopted in many large cities in order to reduce expense, but under that basis it would be necessary to meter only 10 per cent of the Oak Park services, for Oak Park would be considered one of the good controllable districts adapted to periodical inspection, in a city like Chicago, for instance. Under this method, too, the wastage must have taken place before the necessity for stopping it will have become apparent.

Maintenance of Meters. The efficient maintenance of meters is more important than appears at first glance. Meters should be repaired as soon as possible after being reported stopped or otherwise defective. This condition of the meter is usually detected by the readings, supplemented by observations of the meter reader. All suspicious variations in the readings, both high and low, should be investigated promptly. It has been found that frequent readings taken not less than four times a year, preferably more, give satisfaction to the consumer in measuring accurately all the water that is used and in giving ample warning of unavoidable excess consumption. The periodical testing of meters, such as once every 5 years has disclosed many unsuspected defects caused by undue wearing of parts, or the detection of tampering by the consumer. In Oak Park the test of meters which were used by the private company preceding municipal management showed [illegible] 50 per cent, with an average of 2 per cent for the entire system. It also was found that in several cases where the bills were not high in spite of very small leakage that the meters did not register leakage as small as 30 gal. per day

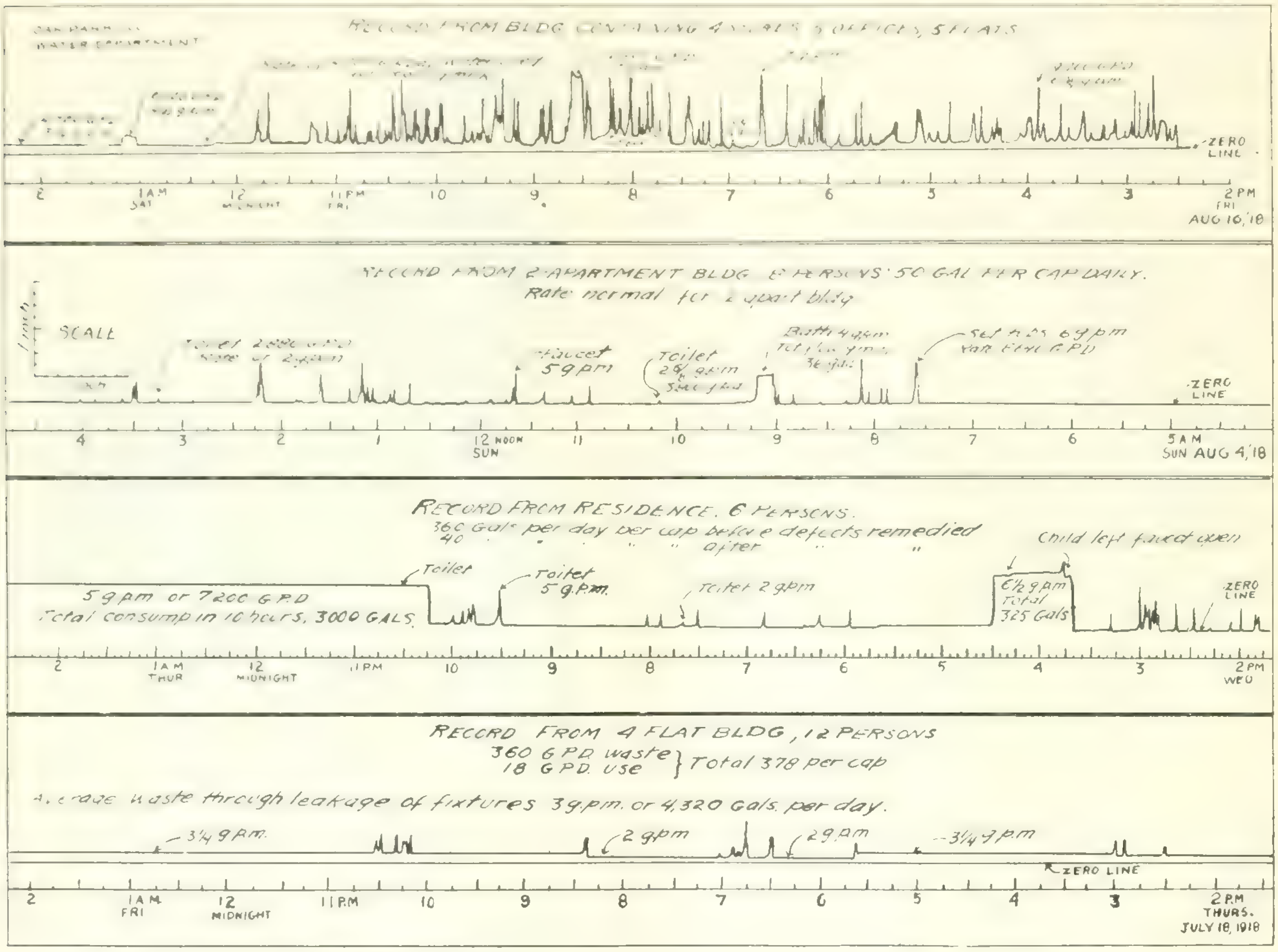


Recorder and Meter Used for Determination of Rate and Character of Domestic Water Consumption.

Complaint Bureau.- The efficient complaint bureau, and the education of the water consumers, are important both for the satisfaction of the water-taker who tends to regard the meter with suspicion and for the peace of mind of the water department executive who realizes that it does not pay to antagonize citizens. The systematic handling of complaints is infinitely more satisfactory than adverse arbitrary decisions, or spineless methods of leniency caused by fear of political pressure or favoritism. Every high bill can and ought to be explained. The problem is really one of education. In the water bill or notifications to the consumer referring to the waste of water. This was supplemented by letters to each consumer with follow-ups in order to test the reduction in consumption after the repair of leaks. The meter readers report all suspicious sounds of running water, although not attempting to trace the cause in order to save time, and the rest is handled in the office by the complaint clerks. If the consumption is abnormal, a special call is made by a complaint inspector before the waste is brought to the attention of the consumer. It was noted that if notices were sent to the consumer before the investigation, he often repaired the fault and then insisted there must be a mistake or that the meter was incorrect, because there could be no leaks. Hence the adoption of a policy of locating serious trouble before reporting it.

No one in Oak Park has ever been obliged to stint in the use of water in order to receive reasonable bills. In fact the leaks consumed 3 to 10 times more water than the consumers themselves can actually use for all purposes. Newly arrived residents from Chicago and other cities with the flat-rate system, have an inborn dread of meters, and when these persons have exorbitant bills, they often begin to be miserly in the use of water, even attesting to the fact that the strictest economy was practiced. Sometimes they threaten to return to their former homes where they had a square deal. Our investigators proved that in every case of that kind there were toilets leaking at the rate of ⅛ to ½ gal. per minute. Sometimes the waste was so small that the watching of the meter did not readily indicate the quantity. Sound is really the best indicator of leaks. This is explained to the consumer who thereafter manages to use all the water he needs, although keeping down the bills. Often a warm meter advocate is thus obtained. It is always a good policy to give the consumer the benefit of the doubt and let it be known that the department is glad to correct errors. In many cases diplomatic cross-examinations will uncover sources of waste which the consumers do not realize. It is dangerous to try to prove that the complainant is wrong until you can show him where. Rectify errors promptly. Service is the important element in popularizing the use of meters.

Aside from the waste through fixtures, high bills are caused by leaks in toilets, broken underground pipes in basements, defective toilet valves or ball-cocks, dripping faucets, thermostats, water motors, pumps operated by water power, defective stop-and-waste cocks, and between walls, water used for cooling food, water wasted to obtain a cool drink, or to procure hot water from defective heaters, children leaving faucets open, lawn sprinkling with hose without nozzles, the flushings of water-closets uselessly after use for purposes for which they are not designed, such as garbage receptacles, leakage through tanks in attics and by allowing water to run continuously in order to prevent freezing, or into washtubs or lavatories for washing purposes, instead of filling the bowls or tubs before using.



Records from New Domestic Water Waste Detector, Oak Park, Ill.

Domestic Waste Detector.—For causes where the department was unable to determine the cause of high bills owing to the fact that there was no leakage and that the consumer was sure he was not wasting water, a recording detector was designed, which when substituted for the meter gives a graphic record of the consumption for 24 hours or a week. This device consists of a piece of brass pipe ½ or ¾ in. in diameter and 7 in. long, into which are inserted two brass tubes 1/16 in. in diameter, one pointed upstream and the other perpendicular to the axis of the pipe. For convenience, these orifices or pitot tubes are soldered into ⅛-in. brass nipples. Two needle valves and strong rubber tubing completes the meter. A special type of recorder with a rapidly revolving chart so that drafts lasting only ½ minute could be detected, was constructed which indicated at what time and how long faucets were left open for baths, for washing dishes or clothes, or for lawn sprinkling; how often toilets were flushed, together with a record of all leakage of 1½ gal. a minute or more. In fact, it was found easy to determine at what time the consumers rose and retired and whether they got up during the night or not.

The short piece of pipe (in reality a brass meter nipple into which are soldered permanently two pitot [illegible] is inserted into the house service either in place of the meter or connected in tandem with it. In all, only two tubes were necessary for the range of consumption which exists between a [illegible] room [illegible] apartment building. In the first experiments the pitot tubes were connected to a mercury U-tube, by means of which rates ranging from less than ½ gal. per minute to 30 gal. per minute were measured by using the ½-in. and ¾-in. nipples. A camera provided with a revolving sheet of bromide paper, 3 in. wide, was designed and adjusted so that the lens magnified the deflections through a slot about eight-thousandths of an inch wide. A pocket flashlight supplied the illumination, through a condenser and the power was furnished by a single-cell storage battery constructed for the purpose. The only drawback to the device was that the high deflections were beyond the range of the slot, although small leakage was detected which the disk meter failed to record.

The next step after fruitless attempts to alter the quantitative measuring device of the displacement meter so that it would register in gallons per minute, was to design a recorder which could take care of all flows. This new recorder will detect rates as low at 1½ gal. per minute, and there is no limit to the maximum recording capacity if larger meter tubes with lower center velocities are used. The diaphragm is constructed of ⅛-in. mechanical rubber, and it is surprising to note the power transmitted through the stuffing box. The recovery after a short draft is rapid, even at maximum velocities, as indicated by the accompanying copies of actual records. The recorder is not extremely accurate but frequent rating by means of the regular meter-testing outfit indicates that it is amply dependable. It has been used successfully in connection with a 2-in. Venturi meter, in making waste surveys by means of the hydrant and hose method, and gives much assistance in determining the varying consumption in the district tested, so that the leakage can be ascertained.

Plumbers invariably mislead the consumer by failing to appreciate small leaks and by discrediting the meter. But Oak Park water-takers are rapidly becoming educated in spite of this. After being shown repeatedly the waste which plumbers failed to locate, and seeing the effect of the stoppage of leaks which, according to the plumbers, could not amount to more than 10 gal. a month—they refuse to be sidetracked.

Cost of Water Mains at Council Bluffs, Ia., from 1907 to 1918.—The following table, from the last annual report of the Board of Waterworks Trustees of Council Bluffs, Ia., shows the cost of laying water mains from 1907 to 1918, inclusive; the costs are for 100 lin. ft. of main and include valves, hydrants and connections:

[illegible]

Year	[illegible]	[illegible]	8 in	10 in.	12 in.	[illegible]
[illegible]		$106.34	[illegible]			
1911	[illegible]					
1911-12	[illegible]		98.31		[illegible]	
1912-13 ...	[illegible]	[illegible]	111.91			
1913	[illegible]					
1914			102.45		163.45	$238.87
1915			138.33	[illegible]		229.74
[illegible]		98.26		139.82		
1917			180.45		‡313.63	
1918		223.83				

[illegible] on the [illegible] under pavement. §Half of mains laid under pavement.

Length and Sizes of C. I. and Cement Lined Mains at Concord, N. H.—The Water Department of Concord, N. H., at the end of 1918 had 70.94 miles of cast iron and cement lined mains in service. The lengths of the various sizes were as follows:

	[illegible] pipe.	[illegible] pipe
24-in.	[illegible]	
[illegible]	1,963	11,391
[illegible]	2,788	
[illegible]	19,788	
[illegible]	24,759	
[illegible]	46,778	1,732
[illegible]	22,836	6,438
[illegible]	115,731	
[illegible]	31,245	1,281

The waterworks were constructed in 1872 and serve a population of 21,497 (1910 census). The supply is by gravity, with pumping to reservoirs for high service and fire protection

Design and Construction Features and Cost of East Canyon Creek Concrete Arch Dam*

[illegible]

The [illegible] 37 miles from Ogden, Utah. The reservoir formed by the dam stores water for late irrigation of lands in the Salt Lake Valley south of Ogden, and forms a part of the irrigation system owned by the Davis & Weber Counties Canal Co., of Ogden. The structure is of interest because of its slight appearance and the successful manner in which it stands the test of use. The arch has a length of 128 ft., the radius of its up-stream face varying from 78 to 98.8 ft. The arched portion is 190 ft. high above bed rock and 145 ft. above the outlet; its thickness is 26 ft. at the bottom and 5 ft. at the top. The arch abuts against a tangent of gravity section on one end, and against a tangent structure of hollow-deck type on the other. The outlet gates are of the full balanced type.

Features of the Site.—At the site of the dam a strong, prominent upheaval of conglomerate rock shows above the mountain slopes for several miles. Where the creek cuts through the conglomerate, a short, deep gorge or canyon, with solid rock walls, makes a favorable place for building a dam. The rock is a limestone conglomerate, formed of fragments of rhyolite, sandstone and limestone cemented together with calcite. The sides of the canyon are very irregular, but, in general, are rough vertical in places overhanging—for the first 40 to 60 ft., and, above the vertical cliffs, the slopes fall back at varying angles. The conformation and quality of the rock fixed the location of the dam at the down-stream toe of the old dam. The body of the old dam precluded the adoption of the best location. It became necessary to locate the dam lower down stream, and even then the excavation cut the toe of the old dam somewhat.

Bed-rock was found 15 ft. below the creek bed, where the average distance between the canyon walls was 45 ft. The surface of the bed-rock was very irregular, being cut with channels and pot-holes, but all smooth and highly polished, evidently by flowing water carrying sand and drift. Some of the pot-holes were as deep as 5 ft., and much larger at the bottom than at the top; and remains of the boulders that ground them out were found in each. There were no cracks or fissures to be found, and the only preparation necessary to make a foundation was some roughening of the polished surface.

The Design.—The peculiarities of the site plainly indicated the adoption of a dam of the arch type. Calculations showed that an arch dam could be built for about one-half the cost of any other type.

All that could be found in print relating to arch dams was studied, and the proposed mathematical treatment was applied to the design of the structure. It was found that in all cases the dimensions necessary to resist the complicated shears, bending and temperature stresses did not exceed the dimensions computed from the simple formula for the strength of cylinders under pressure, when the unit stress on the masonry was conservative. To decide on a conservative unit stress, one must be guided by the quality of the materials, the importance of the structure, etc. Examples are found of arch dams in successful use having stresses ranging from a minimum of 10 tons to a maximum of 61 tons per sq. ft. On account of the importance of the structure, in this case, a stress of 12.5 tons per sq. ft. was adopted

The thickness of the arch was found by using the simple formula,

[illegible]

R = the radius of the up-stream side, in feet;
P = the water pressure, in tons per sq. ft.
S = the stress on the masonry, in tons per sq. ft.

For practical use, let the depth of water at any point be represented by D; it is easily found that RD [illegible] 0.0025 gives the thickness for a stress of 12.5 tons per sq. ft. The thick-

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[illegible] Civil Engineering" printed in the March, 1919 proceedings, pp. [illegible]-113.

ness of the arch in this case was finally determined by the use of this extremely simple formula.

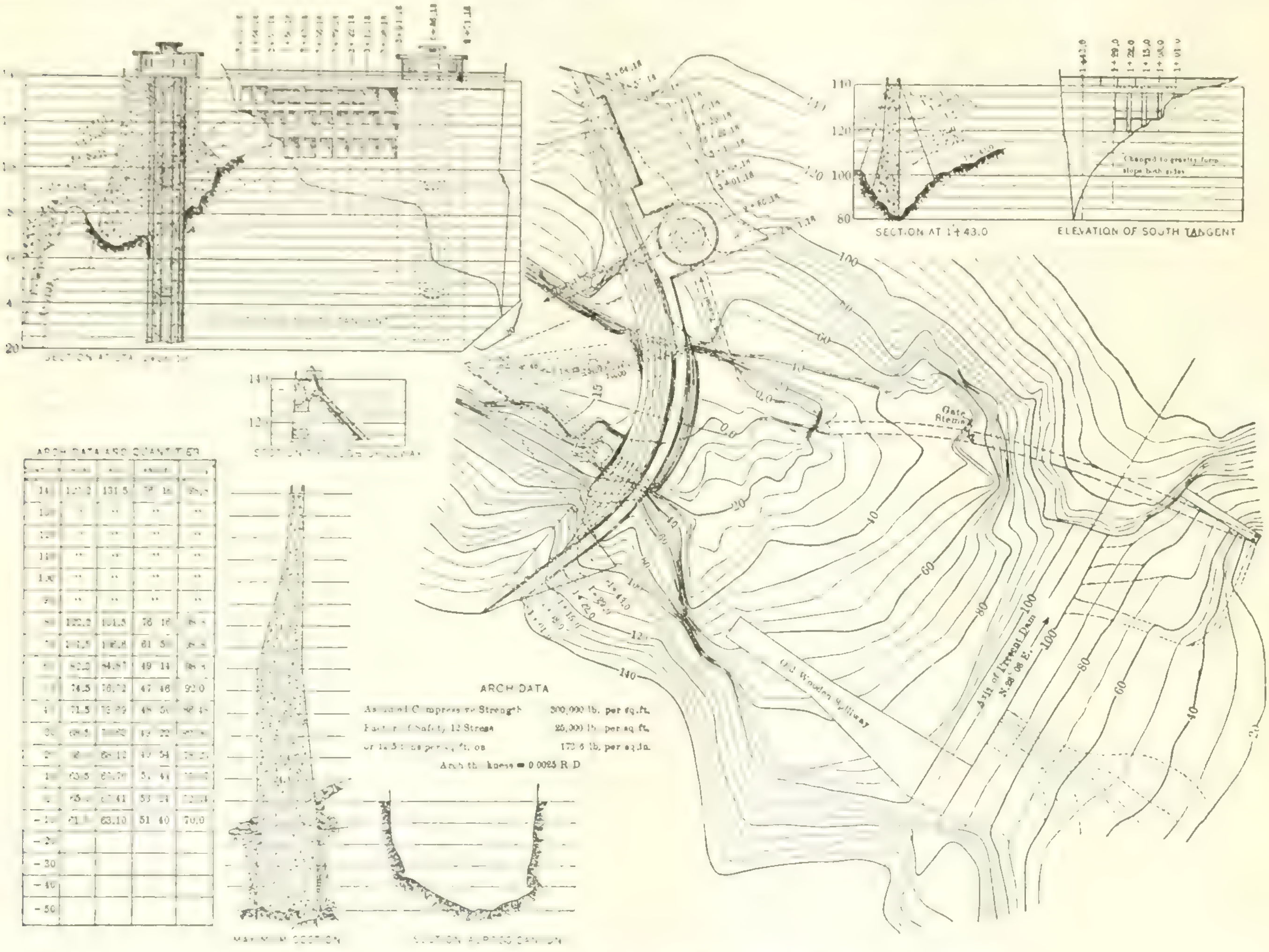
It is always desirable to use as little concrete as is consistent with safety. It is variously stated that the minimum quantity of concrete is needed for a given thickness of dam when the central angle of the arch includes about 133°, when the versed sine is one-third of the chord, or when the radius is equal to the chord multiplied by 0.54. In this case it was found impractical to consider the element of the minimum quantity of concrete; it involved producing overhangs in the faces of the arch, and it is probable that cases are rare where it is practical to maintain a constant angle between the limiting radii. Recorded examples of arch dams show that in some cases local increases of thickness have been made in order to give increased strength; in this case no such additions to the calculated thickness was considered necessary, but in places the joining of the arch to the cliffs had small increases of thickness in order to cover cracks and soft places in the rock, and for no other reason.

The sides of the canyon forming the abutments of the arch have such direction as to be nearly parallel with the center line of the included arch angle, instead of being on radial lines, as is to be desired. To cut into the rock sides to give abutments on radial lines was expensive, and, on the north side, such blasting of rock was too near to the tunnels and gate-shaft for safety; the shaft was located close in, for reasons of economy. Therefore, it was decided to trust to the key afforded by the inequalities of the rock—in this instance unusually favorable for a good key—without blasting out any more rock than was necessary for finding good solid abutments, notwithstanding the fact that the line of the rock made an angle with the line of the resultant of the arch thrust equal to the full angle of repose for masonry. There was placed over such abutments steel dowel pins, of 1-in. square twisted piece, 4 ft. long, placed one-half in the rock, in grouted holes, and the remainder built into the concrete, one dowel to every 3 ft. vertically and horizontally. Such dowels may not do much good, but they certainly give a look of security.

To fit the arch to the cliffs properly, it was found necessary not only to adopt radii varying in length from 70 to 98.8 ft., but at Elevation 60 to change the batter from the up-stream to the down-stream side. The batter begins on the up-stream side of the dam at 10 ft. below the level of the old outlet, assumed for convenience as Elevation 0.0, so that the point 10 ft. below has a minus value. The down-stream side is vertical to Elevation 60, where the batter changes to that side, and is continued thence to the top. The calculations for thickness bring the dam section to a point at the top; but the top thickness is assumed in this instance at 5 ft., and the surface batters downward to meet the other batter at Elevation 110, where the thickness is 7.41 ft. More for appearance than anything else, there is a rib at the top, on the down-stream side, of 8 in. projection and 4 ft. deep. On the up-stream side there is a parapet wall, 3.5 ft. high, and opposite is a railing of 1½ in. pipe supported by posts of 3 in. I-beams; provision is made for the expansion and contraction of the pipe.

The length of the dam over all is 273 ft., the south tangent being 43 ft., the arch 128 ft., and the north tangent 102 ft. Up to about Elevation 60 the arch is not more than 65 ft. long, mostly only from 45 to 50 ft. The excavation for bed-rock extended to 45 ft. below the creek bed, or 50 ft. below the old outlet, which was assumed as the zero of elevations. The total height of the dam is 190 ft. From bed-rock to Elevation — 10 the thickness is constant, because of balanced pressures; the use of forms began at Elevation —10, with a dam thickness of 26.25 ft., but to that level the thickness is from 28 to 30 ft., for in the foundation timbering only the heavy timbers were removed, and the whole space between the lagging was filled with concrete.

The length and radius of the arch was determined by the set of the tangent ends. It was necessary to use tangent ends, for the calculations showed that otherwise a longer radius was needed, and then the ends of the arch would be too nearly parallel with the sides of the canyon; in fact, the dimensions and form adopted showed that the cost of building


SECTION AT 1+43.0
ELEVATION OF SOUTH TANGENT
Changed to gravity form slope both sides
Gate Stems
Old Wooden Spillway
Axis of Arched Dam
ARCH DATA AND QUANTITIES
ARCH DATA
Assumed Compressive Strength 300,000 lb. per sq. ft.
Factor of Safety, 12 Stress 25,000 lb. per sq. ft.
Arch thickness = 0.0025 R D
MAXIMUM SECTION
SECTION ACROSS CANYON

Sections, Elevations and Plan of East Canyon Creek Concrete Arch Dam.

would be less than with any other form tried. The most difficult matter involved in the design was to find a balance of the elements involved, at the same time having due regard for economy and sound rock for abutments. This was only accomplished by patience and many trials of different forms and locations.

The Tangent Ends.—The south tangent of gravity section was first designed as a deck section, but after the foundation to receive it was blasted out, the contour was changed so much that the gravity section with slopes on both sides was substituted. On the north side the rock fell away in such manner that a proper gravity section could not be built on it where the slope of the structure is down-stream, and it became necessary to adopt a hollow-deck section where the sloping side could be up-stream. The deck is formed of arches below and a straight surface above, set on piers 7 ft. from center to center. The foundations of the tangents, perched on the sides of the cliffs, had dowel pins of the same kind as those used in the arch abutments; there were plenty of them, and they were set into the rock before the concrete was placed.

It being necessary for the tangent ends to receive the thrust of the arch and carry it to the rock sides of the canyon, the hollow spaces in the north tangent required special treatment. Accordingly, two heavy braces or ribs were placed, reaching from pier to pier and to the side of the canyon. The lower brace, at Elevation 115, is 7 ft. wide and 4 ft. high, with a reinforcement of 36 rods of 1-in. square twisted steel; the upper one, at Elevation 122, is 6.25 ft. wide and 3 ft. high, with 20 rods of the same size and kind; the horizontal rods in both beams are surrounded with hoops of ½-in. twisted steel every 12 in. The working floor of the spillway provides for the thrust at the top.

The Spillway.—The spillway, 42 ft. wide and 5 ft. deep, is in the north tangent. It is fitted with top-hinged, swinging, steel supports or needles, 3.5 ft. from center to center for supporting ordinary plank flash-boards. It is intended that the ordinary operation of the flash-boards shall be by hand, using hooks on the irons placed for that purpose on the boards. For emergency use there is provided means for prying up the needles by using a steel bar kept for that purpose, until the bottom passes the lower support and allows the needles to swing down stream, thus releasing the boards supported by the needles. In such event the boards released go down stream, and may be lost; but the need for such release is infrequent, and the loss of a few boards of little moment. The spillway apron is from the top of the upper thrust beam to the crest of the spillway; it is arranged to throw the water well away from the dam, where it finds its way to the creek channel without further provision for directing it.

Contraction Joints.—There are only two contraction joints, and they are placed where the arch abuts the tangents. The north joint begins at Elevation 60 and the other at Elevation 80. One side of the joints was built in advance of the other, and a coating of hot DX-grade California paving asphalt was applied to the surface before the remaining concrete was placed. Across the joint, and 2 ft. back from the upstream side, a 1½-in. pipe was placed, one-half in each side; when these pipes were removed, a 2-in. hole was left, and this was run full of the hot asphalt, as additional security against leakage. The joints, being on true radial lines, had no dowels or reinforcing steel extending across; but heavy offsets were made in the concrete.

Steel Reinforcement.—No reinforcement was used until Elevation 50 was reached; from that point to the top, 1-in. square twisted steel was placed in 2-ft. squares and 1 ft. back into the concrete on both sides of the arch. The gravity section tangent has no reinforcement, but the deck type of tangent has a reinforcement of ¾ and ½-in. square twisted steel rods. It was decided to use the steel in the manner described as a compromise of apparent demands of the elements involved—the horizontal steel to stiffen the thinner parts of the arch, the vertical to distribute the ice pressures, and all to prevent cracks. It certainly prevented cracks, but more steel may have been used than was strictly necessary. The heavy reinforcement may be warranted in the interests of safety, especially considering ice thrusts, for ice of great thickness forms here.

The gate-house, parapet wall and gate-tower had a reinforcement of ¾ and ½-in. square twisted steel in all places where its need was evident. The item of structural steel is covered by railings, trash-rack, gate-house doors and shutters, and the spillway fittings. About 90½ tons of reinforcing steel were used. The greater part of this was in the arch but a very considerable quantity was used in dowel pins placed [illegible] building places, as well as in the tower proper and about the gate-house, spillway, and thrust beams; no accurate segregation was made, as all was paid for at one price per pound, regardless of kind or place of use.

The Outlet System. The outlet system comprises an intake tunnel, a discharge tunnel, a vertical gate-tower in a shaft and carrying three balanced gates, set at the bottom of the tower and at the one-third and two-thirds points of the height, a sump or water cushion at the bottom of the gate-tower, and a hand-operated device in the gate-house for opening and closing the gates.

The concrete tower [illegible] diameter of 6 ft.; the walls are 30 in. thick, and the outside diameter is 11 ft. This gate-tower is set in a shaft, 15 ft. in diameter, blasted out of solid rock up to about Elevation 70 and thence to the top forming a part of the north tangent. The annular space about the tower is always full of water, supplied through the intake tunnel; and, on opening a gate, discharge occurs into the 6-ft. opening in the tower, from which it drops to the sump and is discharged thence to the stream through the outlet tunnel. Leading from the reservoir to the annular space in the shaft about the gate-tower is the intake tunnel, 60 ft. long, with a cross-sectional area of 33.8 sq. ft., and with its bottom at the level of the bottom of the lower gate, at Elevation — 5, or 145 ft. below the top of the dam.

The outlet tunnel is also about 60 ft. long, and has a cross-sectional area of 50.2 sq. ft. It is set at a lower elevation than the inlet, and is arranged for a water cushion in the central shaft and a water seal for preventing a draft of air through the gate-tower, thus precluding the formation of ice. This is a matter of importance in this cold place. As it is necessary to draw all water through the old outlet system when the reservoir surface is below Elevation 100, the tunnels were designed to carry only the capacity of the old outlet. It would have been better, perhaps, to have made them larger, in order to avoid excessive velocities with the larger flows possible when the water is higher than the old dam.

The Trash-Rack. The old outlet had been provided with a light steel trash-rack, and, as it had given no trouble during 18 years of use, a similar rack of ½ by 5-in. steel bars, 5 in. from center to center, was placed at the new outlet. The rack rests on four pieces of 90-lb. rails, spanning the shorter way. When the water was drawn off, in the fall of 1917, it was found that trash which had gathered on the rack had reduced the flow of water until the resulting pressure had [illegible] bars. It is fortunate that the rack was not stronger; had it been equal to holding the pressure, a very embarrassing situation would have resulted. No indication of the condition was visible, and it was not suspected until the water was drawn off.

The bent and twisted rack was entirely removed, and the channel between the old and new outlets, about 5 by 5 ft., with an open top, was covered with a grill of pine poles having a minimum diameter of 9 in. These poles have an average length of 16 ft., and span the channel in an inclined position, extending from the outer side of the channel to the rock wall of the cliff on the other side, with clear spaces of 6 in. between the poles. The distance covered is 70 ft. The poles are fastened in place by setting 1-in. steel pins in the rock and using ties of No. 9 galvanized wire. This arrangement has not yet been tested, but promises good results.

The Cylindrical Balanced Gates. Each gate works in a cast-iron ring or cylinder set in the concrete walls of the gate-tower. Each cylinder has six 2 by 2-ft. openings in its perimeter, and these are symmetrically spaced. Freely movable vertically inside of the stationary rings are the gates proper, which are cast-iron cylinders with no openings. When the gates are fully down, the openings in the outer cylinders are closed. At the tops and bottoms of the cylinders are fitted heavy rings of naval bronze; when the inclined faces of the bronze come in contact, a water-tight joint is formed.

This arrangement insures a perfect balance of water pressures. Use has demonstrated that no more force is required to operate these gates under pressure from full heads of water than when there is no pressure. Hand-wheels are all that are needed by operators. The arrangement provided for the purpose works very easily and with such smoothness and [illegible] that nothing better [illegible] power operation could be [illegible].

The Concrete.—The Red Devil brand of cement manufactured at Devils Slide, Utah, was used throughout. The cement passed the tests satisfactorily and it was unnecessary to reject any. A complete apparatus for testing cement and [illegible] was provided at the work, one man being constantly employed on tests.

The sand available had a very forbidding appearance, for it had a large content of fine silt and clay, and, when made [illegible] presented a muddy consistency, but tests showed a fair strength and a good degree of water-tightness. Crushed rock was used for the coarse aggregate.

Tests of mortar composed of the cement and sand showed a satisfactory increase in strength with age, some breaks in [illegible] cement to 3 sand running as high as 500 or over lb. per sq. in. at the age of 3 months.

Briquettes were made from the mortar from the mixer [illegible] the concrete was placed. No breaks could be made at 1 day. At 7 days the tensile strength showed an average of about 100 lb.; at 28 days it was always more than double the strength at 7 days, and at 18 months the minimum was 310 lb. and the maximum 645 lb., with the average running about 500 lb. Breaks were made frequently between the 7-day and 18-month periods, and in no case was there a failure to show an increase of strength with time.

Notwithstanding the bad appearance of the sand, containing as it did much earth, clay and silt, the outcome is very satisfactory, although more cement was used than would have been the case had clean sand been available. It is now known, however, that this concrete is more water-tight than if made with all screenings. All the concrete was mixed with more water than desired, in order to help in placing it in the forms and avoid the formation of rock pockets without mortar. Some concrete in the foundation was placed in water without harm, or any loss of cement, and several times, when the pumps stopped, the surface of fresh concrete was flooded without bad effects, which would not have been the case with concrete made with clean sand.

The proportions of the concrete used in the body of the dam were, as nearly as possible, 1 part cement, 3 parts sand, with some screenings through a ¾-in. screen; and 5 parts broken rock, 3-in. maximum size.

In the body of the dam 4.75 sacks of cement per cu. yd. of concrete were used, and for about 800 cu. yd. about the gate-tower, for tunnel lining, and in the gate-house the quantity was 6.25 sacks per cu. yd. It was planned to use plum rock in the concrete of the dam body, but cold weather prevented, as it was too difficult to remove the snow, ice and dirt from the rock.

Concreting in Cold Weather.—Most of the sand was hauled early, and was in a large pile on the side-hill above the bins; and, becoming wet from the fall storms, froze to a depth of 2 or 3 ft. The broken rock was coated with frozen earth, snow and ice. Notwithstanding the bins being roofed over, the materials often froze together. Nothing was done to overcome these conditions except to mix the concrete with hot water. The concrete as it came from the mixer was just above the freezing point, and, to maintain it at this temperature, it was necessary to keep the water hot and throw out the larger, solidly frozen lumps.

Experience soon showed that the rise of temperature due to chemical changes in setting prevented damage from frost when the concrete in the forms was covered at night. Canvas was spread over the forms, steam jets prevented surface freezing, and the temperature of the mass below the surface soon increased sufficiently to remove any frost occurring there, if not too great in quantity. The steam caused heavy deposits of frozen moisture on the forms; when this melted it caused a very sloppy condition, and so the steam jets were abandoned and salamanders burning coke were substituted, with an improvement of conditions. When concrete was placed on colder days the surface of the fresh concrete often immediately froze over to the depth of an inch or two. It was found that placing fresh concrete thickly over such a surface, quickly thawed it out without harm; but when the freezing was too severe, the frozen part was picked, broken up, and thrown out. Steam jets were used freely to thaw out and remove the ice from the forms, concrete surfaces, and rock walls immediately before placing concrete against them.

The removal of the [illegible]-in. pipes in the contraction joints afforded a very favorable means of testing the rise in temperature in the concrete when setting. Tests of temperature by lowering a thermometer into the holes showed in every case a considerable rise, a typical test showing a temperature of 70° F. at a depth of 15 ft. when the air was at 14° F., a difference of 56 degrees.

The Forms.—The use of forms began at Elevation — 10. Up to that point the excavation was filled to the sheeting. The forms were built in sections 10 ft. high. At the top and bottom of each form 2 by 10-in. plates were placed, and vertical pieces of the same dimensions were set between as studs, 2 ft. from center to center, with 1 by 6-in. sheeting on the studs. At the jointing of the sections horizontal 2 by 6-in. pieces were spiked to each stud, projecting 4 ft., with a 1 by 6-in. brace from below. These brackets formed a place for a working scaffold, and braces upward from the end helped to place the next section of forms.

When a form was filled to the top with concrete, and before it had set, 1-in. steel pins, 4 ft. long, with an eye at the top, were driven into the concrete, about 6 ft. in from the forms. Ties of 4-ply, No. 9 wire, were strung through the eyes in the pins and fastened to each stud at their one-third points of height, thus being inclined sharply upward. The wire ties were then twisted to tightness, and served to hold the forms true against the pressure of about 2 ft. of freshly deposited concrete; the concrete was accordingly placed in layers of about that thickness, moving back and forth as necessary to avoid excessive pressure and the resulting bulging of forms. No wires were allowed to reach from side to side of the dam. Where the thickness of the dam was greatest, two rows of anchor-pins were used, and only one row when the distance between the forms became less. Near the top, in the narrower space, the use of two rows was resumed, with the stay-wires crossing in order to keep proper distance from the forms; at the very thinnest part the wires were attached to the reinforcement. The forms about the gate-tower, spillway and gate-house presented no special features, being of the usual 2 by 6-in. studs, 1-in. sheeting, and wire ties.

The Construction Plant.—The plant presented no unusual features, for it consisted only of ordinary steam-driven machinery, and was all adapted to use on this work from such as the contractors had left on hand from previous jobs. The excavation was dewatered by the three 8-in., belt-driven, centrifugal pumps. Rock drilling was done by machine drills driven by compressed air. Compressed air was also used to drive some of the hoisting engines for the derricks. Rock crushing was done by medium-sized jaw crushers, and all materials were handled by gravity. Concrete was mixed in ¾-yd. Smith mixers, and conveyed by metal-lined chutes to steel mining cars running on a light track on top of the forms.

Cost of the Work.—Table 1 is a detailed statement of the cost of the work, with quantities and unit prices.

TABLE 1. COST OF THE WORK

Tunnel and Spillway Excavation:			
Neat section	[illegible] cu. yd. at [illegible]	$1,646.16	
Overbreak	123.1 cu. yd. at 2.16	265.90	
			$ 1,912.06
Foundation Excavation above Elevation 35:			
Neat section	[illegible] cu. yd. at $2.50	$4,859.75	
Overbreak	25.8 cu. yd. at 1.00	25.80	
			4,885.55
Foundation Excavation below Elevation 35:			
Neat section	[illegible] cu. yd. at $5.00	$2,[illegible]	
Overbreak	[illegible] cu. yd. at 2.00	[illegible]	
			2,815.70
Hauling cement [illegible] at 8½ cts.			16,[illegible]
Reinforcing steel, [illegible] at [illegible] cts.			6,342.00
Concrete—15,888.38 cu. yd. at $5.25, including forms			83,414.00
Cement furnished by the owner			35,712.24
[illegible] and gate shaft [illegible] yd. at $1.45			[illegible]
Balanced cylinder gates			6,250.00
Sundry on Contract:			
Force account		$8,713.70	
Lumber [illegible]		450.00	
Extra form work		500.00	
Structural steel		938.98	
			10,602.68
Inspectors on concrete			778.15
Lands purchased for reservoir			3,123.80
New road around reservoir			5,278.60
Total			$182,134.03
Engineering, 6.15 per cent			11,217.24
Total cost			$193,351.27

The cost per acre-foot was $6.90. The cost of the concrete was $6.37 per cu. yd. The engineering cost covers all preliminary work from the beginning.

Service Test of Dam.—In the season of 1916 the water in the reservoir was raised only to the 100-ft. level, for the concrete work was too new to be put under full pressure. In 1917 the dam was full to the top, and a heavy flow [illegible] over the spillway. It is estimated that the water-shed furnished some 60,000 acre-ft. in that season. During the season of 1918 the entire yield of the water-shed only filled the reservoir to the 120-ft. contour. The dam has thus been fully tested. The gates have passed at times as much as 600 sec.-ft. without shock or jar. In the fall of 1917 the reservoir was completely emptied and the structure carefully inspected. Not a single crack or defect was visible; no sign of weakness, incipient disintegration, or scaling of concrete could be found. The sump was baled out, and it was found that the water in heavy flows falling from a height had not injured the concrete or rock in the slightest degree. The only thing found needing correction was the trash-rack, as already mentioned. When there is no water back of the dam, the contraction joints open about ⅜ in., but, as the water rises, the joints gradually close tight.

Although resting on good, solid, water-tight rock, and joining it on the sides, there were several bedding places and cracks that threatened leaks around the dam. It was not attempted to stop these, because small leaks could do but little damage, beyond loss of water, and it was decided to try them out. As the reservoir was filled, and when the water was about 70 ft. in depth, two leaks appeared on the walls of the canyon, on the south side and about 75 and 125 ft., respectively, down stream from the dam. The combined flow of the two leaks is estimated at 2 sec.-ft.; it is impractical to measure them. When the dam was first put under water pressure there was a heavy seepage or percolation through the concrete, heaviest at the horizontal joinings between concrete forms, but all rapidly reducing in quantity until the percolations were so small that they only showed when in the shade; when the sun shone on the surface it became dry. There was not one leak through the dam or its joining with the rock, nothing more than the percolations mentioned.

The seepage brought to the surface salts from the cement, and they cause a streaked effervescence on the back of the dam; this is very plainly in evidence, and presents a false appearance of leaks that is very misleading, especially in a picture. That there are no leaks is shown by the fact that when the gates were first closed, and until the appearance of the two small leaks mentioned, the flow of the creek was reduced so much that the Fish and Game Commissioner demanded that more water be admitted in order to keep the fish from being destroyed. Accordingly, a gate was opened a little.

When the dam was built it was necessary to leave a hole, 2 ft. square, through it at the lower gate level. This was stopped temporarily by a timber bulkhead. It is planned to place a 14-in. pipe in this opening, and, at the down-stream end, a heavy valve. The latter will be covered with a concrete house to guard against frost and meddlers.

As it is important to know the exact depth of water back of the dam, and its rate of rising or falling, a special device for this purpose has been designed. A heavy copper float, guided by two copper wires set vertically in the annular space about the gate-shaft, is suspended by a plated steel tape; the latter is wound on a 28-in. drum geared down by two reductions to the point where 50 ft. of movement of the tape will cause a movement of 1 ft. on the balancing weight. A wooden rule, 1 ft. long, is attached by the side of the tape to read the fractions of feet. It has not yet been tested, but promises to give good indications of small variations in depth, as this information is most important in the operation of the reservoir.

In spite of the unfavorable conditions of weather under which the dam was built, the fine clayey sand used, and the slight appearance of the arch, it may be pronounced a very successful structure. The contractors are entitled to credit for their faithful prosecution of the work under adverse conditions, and for their patience, courage and fidelity to the interests of good work. The structure was not plastered or patched, but remained just as the forms left it, and with no deviation from true lines; no places show in the least careless or hasty work.

Credit is due to Samuel Fortier, M. Am. Soc. C. E., who, being familiar with the old dam and the conditions of the site, endorsed the building of the new structure. He also gave much valuable advice about its design.

[illegible] Construction Company, of Ogden, Utah, Mr. A. J. Sartons, of Washington, D. C., being directly in charge as superintendent. Mr. H. F. Irwin was the writer's representative on the job.

Cost and Returns of a Home Garden

[illegible] toons in magazines and newspapers throughout the country; [illegible] United States last year added millions of tons of food to the [illegible]

The writer has had a so-called back-yard garden for about 8 years, and just to prove to the "joker" that it is profitable, the following table of the results of the summer of 1918 is [illegible]

[illegible]

Total expense 13.15

[illegible]

The vegetables were not sold, but a monetary value was placed on them which would represent a cost to anyone going to the market to purchase at the time they were harvested.

The products which were not used on the table at the time of gathering were either canned or stored and we have had a good supply of vegetables all winter.

This is the result of an amateur on a piece of land about 50 ft. x 60 ft.; and results could have been better, but this is given to show that the home garden is profitable, and to me a pleasure.—James F. Garvin in the April Stone and Webster Journal.

Carrying Capacity of a Steel Water Supply Main

Results of a discharge test of an 18-in. steel main from [illegible] Jaw, Sask, are given by J. Clark Keith in a letter in The Canadian Engineer. The pipe line is 18-in., plain end, steel tubing, with Custer steel couplings, and furnishes the water supply for the city from a headworks reservoir at a distance of 18.3 miles. The line was constructed in 1912, and has since been in continuous operation, the repairs in the pipe line, with the exception of valves having in the meantime been practically negligible. The main features of the test are summarized below:

[illegible]

The coefficient of friction obtained is much lower than generally used or accepted for cast-iron or steel pipes when new, and is comparable with the coefficients claimed for wood pipe. The reduction in the size of a supply main for a stated discharge, using this coefficient, is very material.

Effect of Pressure, House Connections and Size of Mains and Services on Water Consumption

In a paper presented before the Western Society of Engineers, Mr. H. P. Matte, Chief Sanitary Engineer, Illinois State Department of Health, calls attention to three elements that are seldom taken into account in considering the consumption of water and in comparing the usage in various cities. These elements are: (1) Pressure upon the water system; (2) extent of house connections with sanitary sewers, especially the use of bath tubs, and water closets; (3) effective size of mains and services. Mr. Matte's discussion on these elements follows:

Pressure on Water System.—When per capita rates of consumption are published or mentioned, how often is the average pressure at which the water is supplied included? It is a mistake to omit that item, as it is an important one. A city with a high pressure will find that its leakage rate, both through fixtures and underground piping, will be greater than that of another city which maintains a lower average pressure.

In Oak Park, Ill., the per capita rate of consumption is easily varied between 1 and 2 gal per pound change in pressure within the entire range of rates of consumption. That is to say, 10 lb variation either way will make a difference of 10 to 20 gal per capita daily. Thus the Oak Park rate of 67 gal per capita at 45 lb pressure can be reduced to 45 gal at 25 lb. In Niagara Falls where the per capita rate of consumption was 300 gal per diem, exclusive of the industrial usage the writer determined this rate to be from 3 to 5 gal. per capita for each 10 lb. The Niagara Falls consumption was about 6¼ times that of Oak Park and the average pressure was about 60 lb., which accounts for the different limits, but the principle is the same and its importance is clearly seen. The pumping units were designed for a maximum rate of consumption owing to the heavy drafts and as there were no small units provided, the effect of reducing the fixture leakage by the installation of meters and the house-to-house inspection was to boost the pressure at night some 30 lb. greater, or to 90 lb.; and the effect of reducing the leakage was not evident owing to the greater discharge of water through the remaining defective fixtures.

The following table shows one of the uses of water affected by pressure:

A [illegible] hose [illegible] with nozzle
At [illegible] discharges [illegible] gal. per day in form of jet
At [illegible] discharges [illegible] gal. per day in form of jet
At [illegible] discharges [illegible] gal. per day in form of spray
At [illegible] discharges [illegible] gal. per day in form of spray

These figures have been obtained from tables prepared by Manager Sullivan of the Nashua, N. H., Water Co.

Extent of Connections with Sanitary Sewers.—Another element which is noteworthy in its effect on water consumption is the use of water-closets and bathtubs. Although the number of consumers on the line of pipes are often considered in computing per capita consumption, it is seldom that the number of consumers which have the use of faucets only are separated from those which have all the sanitary conveniences.

In Oak Park from numerous experiments, we determined that the average number of gallons per capita consumed by water-closets where no leaks or waste existed was 20; while under the same conditions the average family consumed 15 gal. per capita through bathtubs. An interesting fact connected with the use of bathtubs is that a person who takes cold baths every morning is very likely to consume 40 gal. per day in this item alone. A psychological effect of the lack of pressure is that the increased length of time required to fill bathtubs oftentimes reduces the quantity of water used for baths.

The records from the following cities show the effect of the installation of sewers upon the general water consumption.

City.	Before installation of sewers.	After installation of sewers.
Marlboro, Mass.	21 gal per day per capita	38 gal per day per capita
[illegible]	[illegible] per capita	[illegible] per day per capita
[illegible]	[illegible]	[illegible] per day per capita

In Madison, Wis., the per capita daily consumption in residences with sewer connections was 68, while in residences without sewer connection it was 11.

In Rochester, N. Y., services with water-closets consumed [illegible] gal per day per capita, services with water-closets and no baths consumed 18 gal per day per capita, and services with water-closets or baths consumed 14 gal. per day per capita.

The limited extent of services and sewer connections in foreign cities, thus cutting down the number of outlets for consumption and fixture leakage, is responsible for the low per capita consumption in those cities. From figures obtained three or four years ago it was noted that the large European cities of over 2,000,000 population had about as many service connections as the average city of 300,000 in this country, while the number of services in foreign cities of about 250,000 population equaled that of our cities of 40,000 population.

Effective Size of Services and Mains. Data on the subject are limited, but the difficulty experienced through loss of pressure by friction from the reduced area of corroded lime-coated service pipes and water pipes filled with algae, crenothrix and tubercles indicate the importance of the effective size of service pipes and mains on leakage and waste. Water bills on metered premises in which leakage and waste exist often double in size after the removal of service pipes, both in ground and in the interior of the house, especially when iron pipe has been replaced.

The following table compiled from some experiments conducted by the Department of Water Supply, Gas and Electricity of New York City, throws more light on this subject:

PRESSURE IN STREET MAINS REQUIRED TO GIVE THE TABULATED DISCHARGE THROUGH A CORPORATION COCK AND 30 FT. OF LEAD SERVICE PIPE.

Gal. per minute	1 in. service Lb. per sq. in.	¾ in. service Lb. per sq. in.	⅝ in. service Lb. per sq. in.
5		2	3
10	..	5	10
15	3	11	23
20	5	18	38
25	8	28	54

Premium Rates for State Compensation Insurance on Hetch Hetchy Water Supply Project

Besides providing hospital conveniences and medical treatment all men engaged in Tuolumne county, California, on the Hetch Hetchy water supply project of San Francisco, Cal., are insured with the California State Compensation Insurance Fund. The premium rates per $100 paid on the various classes of labor on this work are given in the last annual report of the Bureau of Engineering of San Francisco, as follows:

Surveying and inspecting engineer work—including shop work incident to surveying and inspection of construction, operation, but not including actual construction work or superintendence of same..................	$ [illegible]
Commissary work	1.232
Saw mills	4.224
Logging and lumbering—including transportation of logs to mill, but not including mill operation..................	5.074
Waterworks—construction of pumping stations, dams and reservoirs	6.10
Tunneling—including all work to completion (special rate)..	7.327
Blasting—includes storage, handling and use of explosives, also loading, capping and firing ..	18.10
Road or street making and repairing—includes operation of road-making machinery, trucks, etc.	2.341
Railroad construction—steam, electric, horse or cable	1.624
Bridge building—wood (no blasting)..................	6.987
Masonry or concrete work	2.12
Carpentry—including interior trim and cabinet work........	2.031
Cellar excavating	2.43
Shop employees (railroad)	2.312
Clerical office employees (railroad)	.193
All other employees (railroad)..................	6.987
Electric light and power line—construction work exclusively—on transmission lines not intended for local distribution.	4.853
Electric light and power companies—operation, maintenance, extension of lines and making of service connections......	4.853
Electrical apparatus—erection and repair work only, including installation of equipment, etc..................	1.462
Canals—construction	5.304
Fence construction (wood, stone, metal or concrete)........	2.116
Farming and-or ranching	1.547
Flume construction	6.987
Janitors	1.603
Millwright work—erection and repair of machinery	2.13
Stone crushing (no quarrying)	4.624
Telegraph and telephone construction	2.915
Shaft sinking	11.594

The above rates are approximately 15 per cent lower than the regular rates. This reduction was made by the State Compensation Fund on account of the establishment of a hospital on the work.

Coal Tar Derivative Waste Products Cause of Obnoxious Taste of Milwaukee Water Supply

Obnoxious odor and taste appearing at times last year in the water supply of Milwaukee, Wis., were found to be due to coal tar derivation waste products discharged into the lake by industrial plants. An interesting account of the investigations that lead to the discovery is given in the last annual report of H. P. Bohmann, superintendent of waterworks of Milwaukee. The matter following is abstracted from the above mentioned report.

The tastes and odors, which the average person described as of a "medicinal character," and very much resembling carbolic acid or iodoform, became so frequent and so intense with each recurrence during the past year that the water supply was totally unfit for consumption during such periods. The taste remained in the water even after boiling, in fact, the taste seemed more pronounced after the water was boiled. At first, these odors and tastes were attributed to the use of chlorine in disinfecting the water supply and whenever taste appeared, the quantity of chlorine was reduced, although it was soon discovered that the obnoxious taste frequently appeared when lesser quantities of chlorine were used and was absent when larger quantities were being applied. It was also discovered that the appearance of the objectionable tastes and odors in the city water were always accompanied by south or southwest winds, which blow the contaminated water from the harbor outlet, where the three rivers which flow through the city, unite and discharge their sewage-laden contents into the lake, and thence to the intake, which is only 3½ miles from the harbor outlet in a northeasterly direction.

As the chlorine treatment is in charge of a competent chemist and is applied under the most careful supervision, and tastes and odors appeared only when the wind was from a certain direction, the city officials were convinced that the tastes and odors were not due to the use of chlorine alone, but that the action of the chlorine on some of the organic matter present in the polluted lake water formed compounds that produced taste and odor. That chlorine, in the quantities used (.22 to .34 P. P. M.) to disinfect the water supply was not a factor in itself in producing tastes and odors, was also apparent from the fact that taste was present on days when there was less free chlorine in the tap water in various parts of the city than on days when the quantity of free chlorine was 50 per cent greater, and taste and odor absent, although the quantity of chlorine applied was the same on both dates.

In discussing the matter of tastes in water supplies with a member of the American Water Works Association, while attending the Association Convention at Richmond, Va., Mr. Bohmann learned that he had experienced similar trouble and that he attributed it to the industrial waste from a coke plant getting into their water supply. With this information as a key to a possible solution of the Milwaukee troubles, samples were taken of the effluents being discharged at the local coke and gas plants. In the water works laboratory chlorine was added to a sample of tasteless raw water until the ortho-tolidin test showed .09 P. P. M. of free chlorine in the sample, this amount of free chlorine representing the maximum that the tap water has ever contained. The addition of chlorine did not produce any taste to the sample. After the addition of some of the effluent from the coke plant to the chlorinated sample, the sample had a decided taste, resembling that of coal-tar derivatives and was almost identical with the characteristic taste at times present in our water supply. The sample was then boiled and cooled to its former temperature. After boiling and cooling, the ortho-tolidin test showed no free chlorine present, while the taste was there to a greater degree than before boiling.

The result of the initial test of the first three samples pointed to coal-tar derivative wastes in combination with the chlorine added to the water supply. These substitution or additive compounds are probably the direct cause of the taste in the water. Such compounds boil at a higher temperature than water and therefore would not be expelled in boiling. When this fact was established, all further investigations of the cause of the taste in the city water were carried on jointly by Robt. L. Piper, chemist of the water works, and Russell W. Cunliffe, city chemist.

In order to prove that [illegible] derivative waste products from industrial plants, in combination with the chlorine used to [illegible] water supply, [illegible] the [illegible] taste and odor at times present in the water supply, nearly 900 samples of sewage and trade wastes of every description were secured and tested for taste in the manner above described, since it is impossible to prove the presence of these substances, when greatly diluted in the lake, by any chemical determination. It was only from samples of effluents of coal-tar derivative nature that the characteristic and obnoxious taste could be reproduced in the laboratory. All other samples failed to produce this taste. Tests made show that sufficient chlorine can be added [illegible] water to produce a distinctive chlorine taste, which, however, is quite different from the taste complained of. It was also found that the chlorine taste could always be removed by boiling or neutralized by sodium thiosulphate. The objectionable taste complained of in the city water, however, could not be removed by either of these two methods. Tests were also made on solutions of tasteless raw water with various substances, such as naphthalene, benzol, phenol, petroleum oil, etc. It was found that only such solutions which contained substances of coal-tar derivation produced the taste complained of upon chlorination.

From results of laboratory tests [illegible] from .22 to .3 P. P. M. of free chlorine before the chlorine taste becomes noticeable in the sample tested for taste. Since the amount of free chlorine in the tap water has at no time exceeded [illegible] and the amount of chlorine applied is only from .22 to .31 P. P. M., the city officials held certain that the objectionable taste noticed from time to time was not due to free chlorine, but to a combination of chlorine and certain coal tar derivative waste products.

A survey made of all industrial plants whose industrial wastes contained objectionable elements of coal-tar derivation, indicated that in addition to the local coke and gas plants, there were five plants located outside of the city whose effluent might possibly contribute to our water pollution. Of the five plants located outside of the city, three were located at Carrollville, which is about 8 miles south of the southern city limits, and about 13 miles distant from the water intake. The three plants located at Carrollville were under suspicion from the start as contributors to the trouble, although it was impossible for a long time to establish this fact, owing to the difficulty of securing samples out in the lake when wind conditions were favorable. However, at a later trip, the fact was established beyond doubt as samples were secured at various points in the lake between the water works intake and Carrollville, which upon chlorination produced the objectionable taste in varying degrees.

One of the three plants at Carrollville was engaged in the production of phenol for the United States Government, partly in its own plant and partly in a building owned by the Government. The combined production of phenol in the two plants, which originally amounted to only a few tons a day, had greatly increased until the quantity produced during the month of October, 1918, amounted to 130 tons daily. It was estimated by the management that the daily trade waste flowing into the lake contained anywhere from 1,100 to 2,200 lb. of phenol, and the management was inclined to believe that the latter figure was more nearly correct. The possibilities of producing taste in a water supply can best be appreciated when we learn that taste can be produced, after [illegible]

When the obnoxious taste again appeared in a very acute form early in November, a committee was appointed by the mayor to study the report made by the chemists, visit all of the plants under suspicion, and, if possible, place the responsibility for the obnoxious taste in our water supply. The conclusions of the committee were:

"That from its personal investigation and from a careful study of the reports that have been worked out by the chemists of the water department and health department and industrial companies, that the obnoxious odor and taste complained of in the Milwaukee water supply are essentially attributable to the effluent coming from a plant engaged in the manufacture of carbolic acid.

more phenol will be produced there. This will undoubtedly remove the largest factor in the water trouble.

The next largest contributor was the coke company, where it was estimated that about [illegible] lb. of phenol was discharged daily with its industrial waste. It was estimated that the amount of trade waste having taste producing properties leaving the coke plant daily, was sufficient to impart taste of the kind complained of in our water supply to 10 to 40 billion gallons of water. The other plants contribute to this pollution according to the volume of effluents being discharged from their respective plants, all of them, however, to a far less degree. The taste producing properties of the effluents of the plants investigated were found to range from dilutions of 1 to 100 to 1 to 100,000.

Basing opinion on the results of the many tests made, it is reasonable to assume that any water supply which is being chlorined and which occasionally has a medicinal or phenol-like taste which cannot be removed by boiling, may have been contaminated with waste material produced in the destructive distillation of coal and in the recovery and manufacture of the by-products of this process, otherwise it should be possible to remove the taste by boiling. The only practical method known at the present time to avoid taste of this nature is to keep this particular kind of effluent out of a water supply. No water supply will be polluted with coal-tar derivatives and where chlorine is used as a sterilizing agent, can be made palatable for drinking purposes. It is possible that by laboratory experiments, some chemical may be found which will overcome the affinity of chlorine for the coal-tar bodies or change their composition so that they will not unite with chlorine. Every effort is being made by the coke and gas companies to find a method of taking care of their industrial wastes.

Water Works Statistics at Hartford, Conn., for 1918

During the year ending March 1, 1918, the average daily draft for the city of Hartford, Conn., was 11,436,000 gals., according to the recent report of Caleb Mills Saville, Manager and Chief Engineer. The maximum and minimum daily rates of consumption were 126 per cent and 82 per cent of the average daily rate. The average daily per capita consumption was 74.5 gal. The unaccountable water was 17.4 per cent of the total, or 13 gal. per capita per day.

Chlorine gas for sterilization averaged 0.82 ppm., giving a bacterial removal of 96.1 per cent. The color of the untreated water averaged 28 ppm.

Eighty-one per cent of the taps are metered.

Water Consumption and Waste at Waltham, Mass.—The total pumpage at the waterworks of Waltham, Mass., in 1918 kas 95,000,000 gal. greater than in the previous year. The average daily consumption increased from about 2,250,000 gal. in 1917 to over 2,500,000 gal. in 1918. The daily per capita consumption shows a corresponding increase from 70.9 to 78.4 gal. The water waste, as measured by the amount drawn from the stand-pipe during the hours of 1 to 4 A. M., was at the daily rate of 51.6 gal. per capita as compared with only 43.8 gal. in 1917. That this increase in consumption and waste was largely due to the very severe weather in the early months of the year and the resultant leaks that followed is shown by the following figures:

	Average daily consumption. Gal.	Waste rate per day per capita. Gal.
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	45.[illegible]
1918—12 months	2,509,900	51.6
[illegible]	[illegible]	43.8

The following table shows the increase of meters and the waste as indicated by night loss:

Year	Per cent of services metered	Waste rate per capita per day in gallons
[illegible]	1[illegible]	[illegible]
[illegible]	1[illegible]	58.7
[illegible]	1[illegible]	61.[illegible]
[illegible]	[illegible]	6[illegible]
1914	34	51.
[illegible]	[illegible]	45.[illegible]
[illegible]	[illegible]	41.7
[illegible]	[illegible]	43.8
1918	77.6	51.6

The largest volume of water pumped in one day was 3,629,300 gal. on Feb. 6, 1918; while the smallest was 2,075,500 gal, on Oct. 7, 1918.

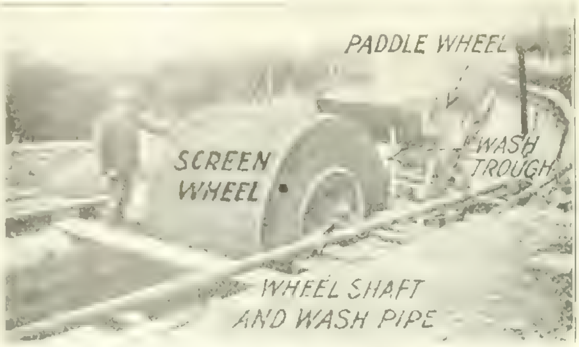
Screen Wheel for Removal of Algae in Irrigation Canal

By E. COURT EATON,

Superintendent, Lindsay Strathmore Irrigation District

A good deal of trouble was experienced by the Lindsay Strathmore Irrigation District of Lindsay, Cal., during the season of 1918 with algae or "moss" in an open lined canal. To prevent the particles of this growth from entering the distributing pipes of the system, removable screens were first placed in the canal and these were taken out and washed with a hose as required. It was found, however, that these screens required the continued presence of a man day and night, as they needed cleaning every 15 minutes. To do away with this expense a revolving screen wheel was designed.

The canal has a bottom width of 6.3 ft. and a total depth of 3.5 ft. A rotary drum made of two circular sections of 3-in. lumber was made up and suitably braced. This was covered with a galvanized screen having a ¼-in. mesh; four vanes, or paddles were placed inside this, it being the intention to have the wheel rotated by the velocity of the water in the canal.



Screen Wheel for Removal of Algae from Irrigation Canal.

It was soon found, however, that this had a tendency to roll the streamers of algae under the wheel and thus allow a large percentage to pass the wheels. Accordingly the paddles were removed and a separate paddle-wheel built in upstream, connected by a crossed belt of cable to the screen wheel, and by this means the wheel was rotated in a direction against the flow of the water. To assist in picking up the larger particles, six rows of nails were driven into the circumference, parallel with the axis.

The screen wheel is supported by, and rotates on, a length of 4-in. wrought iron pipe as a shaft, and this pipe is perforated with a row of 3/16-in. holes. One end of this pipe is connected to one of the pressure mains from the pumps, thus washing off the collection of moss at each revolution, which is caught in a trough and run to waste.

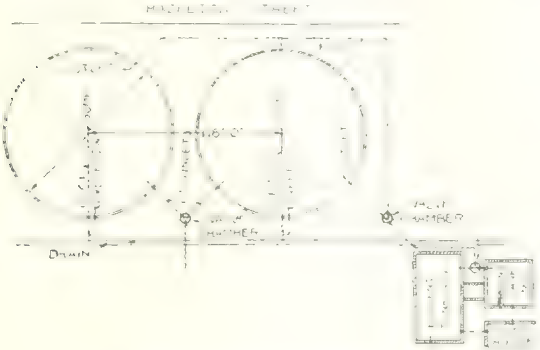
The wheel has been successful and would be improved if built up of steel allowing smaller clearances between the bottom and sides of the canal and the rotating wheel. A good deal of water is necessary to clean the screens, this depending, of course, on the quantity of material to be removed.

Cost of Horse Maintenance for Garbage and Refuse Collection at Columbus, O.—The Division of Garbage and Refuse Collection of Columbus, O., maintained 153 horses during 1918. In feeding and caring for these horses 17 men and a night watchman were employed. There was 774 tons of hay, 1,090 bushels of corn, 18,207 bushels oats, and 130 tons of straw used for feeding and bedding the horses. The cost of feeding each horse per day was $.6727. The cost of caring for each horse per day, including labor, harness supplies and veterinary services, was $.3925. The cost of shoeing each horse per day was $.1107. The total cost of keeping each horse per day was $1.1759. The cost of keeping a horse per day in 1917, was $.9665. The increased cost of $.2094 per day in 1918, was largely caused by the increase in cost of labor and horse feed, the latter item alone being 31 per cent higher than in the previous year.

Design and Construction Features of Circular Concrete Reservoirs Leamington, Ont.

The town of Leamington, Ont., obtains its water from springs situated 1½ miles from the pump house. The supply is carried through a gravity pipe line. As the supply is barely large enough to meet the demands made upon the system during the hot weather, it was decided to improve the facilities by constructing a reservoir to provide a storage capacity of 1,000,000 gal. It was first planned to build this reservoir rectangular in shape with a cross dividing wall, but upon preliminary designs and estimates being made, it was found that by constructing two circular reservoirs, considerable saving would be made in the cost of construction. The main features of these reservoirs are described by Mr. Edward M. Proctor, of James, London & Hertzberg, Ltd., Consulting Engineers, in The Canadian Engineer, to which we are indebted for the matter in this article.

The general layout of the reservoirs and the features of the design are shown in the illustrations. The tanks are 100 ft. in diameter and are located 116 ft. center to center.



General Plan of Reservoirs.

Each tank consists of a floor, a circular wall, interior columns and a wooden roof. The columns are 12 by 12 in. concrete, resting on a footing 24 by 24 in., and each reinforced with four ½-in. steel rods. These columns are in two circles, the inner one 30 ft. in diameter and the outer one 18 ft. from the inner circle. The roof is of wood, treated with three coats of Barrett's "Carbosota Creosote" paint, and is carried by 2 by 12-in. rafters, bearing on pine timbers, which span from column to column. These spans are 15 to 17 ft. The center portion of the roof above the louvre is carried by means of one wooden truss supporting a center block 12 in. in diameter, to which the joists connect. The louvre has a vertical opening of 18 in. and is covered with wire screen to keep out birds and insects. Over the entire roof is a 4-ply tar and gravel cover. The roof has a slope of about 2 ft. 9 in. in 35 ft.

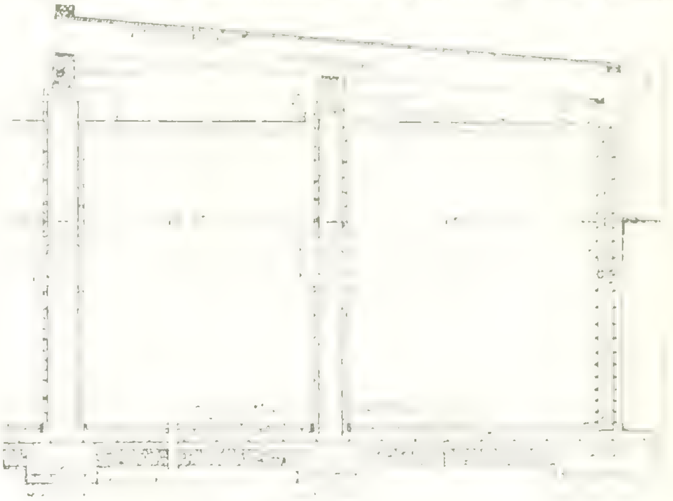
The floor of the reservoir is constructed in two courses, the lower course being 5½ in. of concrete, reinforced both ways with ½-in. diameter rods at 12-in. centers. On top of this course was mopped two-ply of 8-oz. burlap, swabbed on with hot asphalt, all joints being lapped. Above this burlap course was laid a 3-in. course of concrete, reinforced both ways with ¼-in. rods at 5-in. centers. Around all columns a 1-in. asphalt joint was constructed, and between this 3-in. top layer of concrete and the wall, a 2-in. asphalt joint was made. The lower course was laid directly upon the soil. The 6 in. of gravel were omitted, the reason being that the soil was pure sand, making an excellent foundation.

Part Section Through Reservoir.

As the ground water level was about 1 ft. above the level of the floor, and to avoid any possibility of hydrostatic thrust on the floor when the tanks are emptied, a system of drainage was installed. This consists of 4-in. field tile at 12-ft. centers, connecting into a main 5-in. tile under each tank. A 5-in. vitrified tile laid with open joints was laid around the complete circumference, and into this was connected the 4-in. cast-iron downspouts from the roof, which were eight in number for each basin.

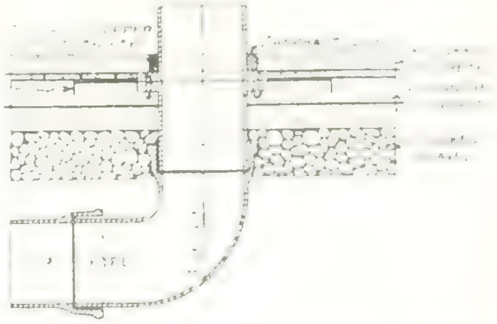
Perhaps the most interesting part of the design is the circular wall. This wall is 12 in. thick and is reinforced circumferentially by means of the following rods: Twenty-two 1⅛-in. diameter, near the bottom, spaced from 4 to 6 in. apart; then six 1-in. rods at 6-in. spacing; and the top course, fourteen ¾-in. rods at from 6 to 9 in. centers. These rods are supported on structural steel struts, built of two angles, 2½ by 2 by ¼ in., connected by batten plates. These supports are placed at 8-ft. centers.

This circular wall bears on a footing 3 ft. in width, which is also circular. The rods in the lower course of the floor projected from this footing. The wall is corbelled out at the top to provide for a gutter.



Cross Section Through Reservoir.

This wall has no physical connection with the footing. [illegible] was first poured and finished with a trowelled surface, upon which was applied a coating of asphalt. The outer forms were erected, and then the reinforcing was placed, after which the inner forms were placed, and when all was in readiness the concrete for the entire wall was poured continuously. The steel takes up the entire circumferential stresses, the concrete being simply a covering for the steel and means of containing the water. By leaving the wall free at its base, expansion and contraction stresses are eliminated. In order to provide assurance that the concrete will not crack when subject to full stress, a unit stress in the steel of 4,000 lb. per square inch was adopted. This unit stress is low enough that the resulting elongation in the steel will not crack the concrete.



Section Through Floor Showing Inlet Pipe

In the accompanying drawings is shown the method that [illegible] the floor and to waterproof around them. This was accom- [illegible] sheet, bolted between machine flanged joints on the pipe. A 1-in. asphalt joint was made around each pipe. These joints were found to be very satisfactory and have been absolutely water-tight.

Considerable study was given to this design to secure an [illegible] necessary because these tanks are in the center of the residential section of the town. After the premises have been sodded, the tanks will look even more attractive than they do at present, the white concrete making a rather pleasing contrast with the steel gates.

The concrete used on this work was as follows: For the walls, 1:1½:3; the lower 6-in. course of the floor, 1:2:4; footings and columns, 1:2:4.

The specifications called for 10 per cent of hydrated lime to be added to the concrete; that is, 10 per cent by volume of the amount of cement used. With this mix a very dense and easily handled mix of concrete was obtained.

Reinforcing steel of a low grade was permitted on account of the low unit stress which was adopted.

The contract for this reservoir was let on the basis of cost plus $2,800 for contractor's profit, and the total cost, including this profit, was $11,115. This cost was made up of the following items:

Labor	[illegible]
Reinforcing steel	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	180
[illegible]	113
[illegible]	750
[illegible]	[illegible]
Surety bond	[illegible]
Freight	[illegible]
Workmen's compensation	196
Miscellaneous	256
Contractor's profit	2,800
Total	$11,115

The tenders were received in August, 1918. The contract was awarded Aug. 23rd to the R. Westcott Co., of Windsor, Ont. Construction was started immediately, and basins were completed, ready for holding water, by the end of the year. The engineer in charge was J. J. Newman, of Windsor, who is town engineer of Leamington. The plans and specifications were prepared by James, Loudon & Hertzberg, Ltd., consulting engineers, Toronto.

The reservoirs have been filled for nearly five months and have shown no leakage excepting at two or three small pin holes, which have been easily plugged, and now the reservoirs are absolutely water-tight.

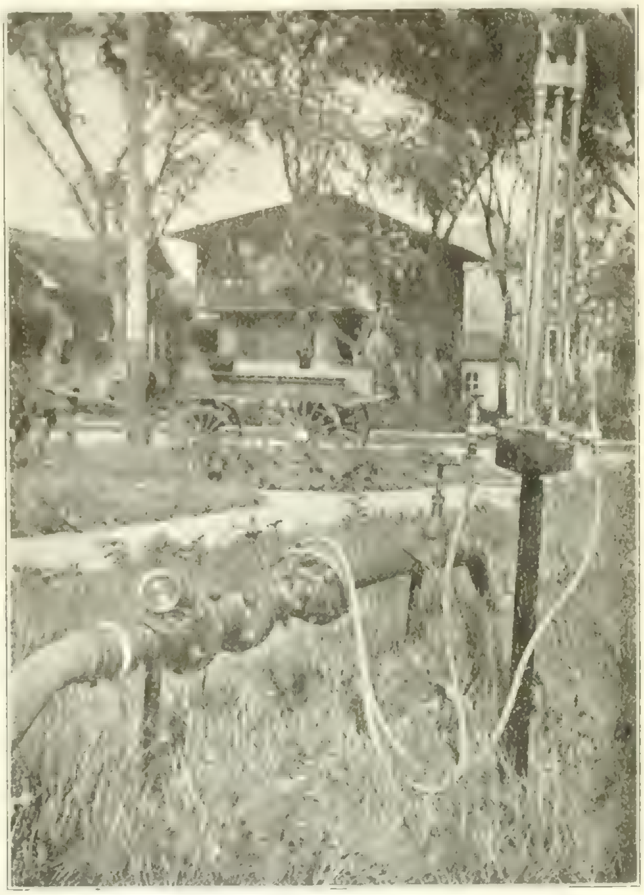
Methods of Making Water Waste Surveys at Oak Park, Ill.*

In making waste surveys the most convenient method is to make, first, a rough survey of the entire city by means of a pitometer. This is done by isolating certain districts by closing gate valves and measuring the supply through one of the mains left open to serve as a feeder. It is possible on small systems to make the preliminary test by shutting down those districts entirely for a few minutes, especially in the residential sections and note the drop in the rate of consumption as indicated by the recording chart at the pumping station or reservoir, or wherever the master meter may be located, providing it is on the distributing system.

It is often found, however, in districts which are completely metered that the velocity of the smallest feed main is so low that it is impossible to obtain an accurate record of the consumption if there are no large leaks. It is then necessary to by-pass the flow of water through a small pipe, 2 in. or smaller in diameter in order to increase the velocity. This is commonly called the hydrant-and-hose method because the most practical way of doing it is to feed from a fire hydrant, without the district, through a fire hose to a hydrant within the district. Oftentimes a regular displacement meter is used and the rate is obtained by noting the readings of the meter at regular intervals. This method is not a very useful one owing to the fact that several drafts may occur during the test. In Oak Park two other methods have been used. One consists of a 2-in. Venturi meter with a ⅝-in. throat which can accurately record rates from 3 gal. to 50 gal. a minute. The other is by means of pitometers inserted into short pieces of pipe 2 in. or smaller. Thus a quantity as low as ¼ gal. per minute can be measured.

Contrary to the usual method of making waste surveys, all tests are made during the daytime, after determining the best hours in which the flow is somewhat steady, from inspection of the Venturi meter at the pumping station. The districts tested varied between ¼ mile and 2 miles in length. By being able to watch the rate of consumption, it is rarely found necessary to be on the job for more than half an hour at a time in order to determine the minimum rate of consumption.

The exact population of the district tested is obtained, as well as the average daily consumption through the domestic meters—the former from the prevailing school census and the latter from the water accounts. Thus an estimate of the legitimate rate exclusive of the underground leakage is determined. In all cases where there is not much leakage the normal pressure is maintained through 600 ft. of fire hose. In order to bring the reading within the limits of the manometer where the flow is abnormal the valve on the meter is throttled. In one case a rate of 60,000 gal. per day at 10 lb. pressure in a stretch of pipe only ½ mile long was observed, the normal pressure in the mains being 45 lb. per square inch. Subsequent investigation by means of the aquaphone disclosed 6 service leaks which wasted water into the sewer at the rate of 200,000 gal. per day. This meant a leakage per capita rate of 305 gal. per day, while the service meters indicated only a total per capita consumption of 45 gal., but after the repairs were made the leakage rate per capita dropped to 10 gal. a day.



Hydrant and Hose Method of Making Water Waste Surveys Using 2 in. x [illegible] in. Venturi Meter with Mercury Barometric Manometer.

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*[illegible] of Engineers by Herbert P. Matte, chief sanitary engineer of the Illinois [illegible]

Water Consumption at Springfield, Mass., in 1918

The average daily consumption of water in the Springfield, Mass., district for 1918 was 12,970,000 gal., according to the last annual report of Chief Engineer Elbert E. Lochridge. The maximum and minimum daily consumption were 15,570,000 gal. in July, 1918, and 9,890,000 gal. in December, 1918. The population supplied was 111,898, which would make an average per capita consumption of 118 gal. per day, with 131 and 83 gal. as the maximum and minimum daily per capita consumption. Services metered constituted 71.11 per cent. The unaccountable water for 1918 was 28.81 per cent, as against 25.95 per cent in 1917. The West Parish Filters were operated at net cost of $4.73 per million gal.

MANAGEMENT AND OFFICE SYSTEM

This section is published twice a month: (1) In the Waterworks and Hydraulic Monthly issue, and (2) in the Railway and Excavation Monthly issue. It covers what may be broadly termed "management engineering" as applied in the civil engineering and construction fields.

A List of Selected Business and Management Books

Ten years ago there were relatively few books on business, management, cost keeping, accounting, etc. Now there are more than 2,000 books on "business." Sarah B. Bell has compiled a book of 232 pages, entitled "1,600 Business Books," ($1.50), published by H. W. Wilson Co., New York City. The 1917 edition contains 2,160 titles of business books.

Scovell, Wellington & Co., Accountants and Industrial Engineers, of Boston, recently issued a pamphlet listing about 370 "selected professional and business books." Believing that this list will be of value to many of our readers, we reprint it in full. We quote from its preface:

"Twenty years ago there were very few books on accountancy, industrial engineering and related business topics. The difficulty was to find anything really worth reading. Today there are hundreds—literally. **One well known list,** compiled in 1916, carries 1,600 titles. A new edition this year contains **2,160 titles,** although it is still called "1,600 Business Books." The difficulty today is to select what is most worth while.

"To meet this need for our ow norganization, we have compiled the following list of titles. These volumes obviously vary widely in character and quality, and in importance to different persons. Some are the product of able scholars, or men with broad professional training. Some are commonplace little manuals hammered out from the practical experience of every-day work. All can be of value if used in the right way.

"The arrangement of titles under the several headings is purely a matter of expediency. In some instances, elementary works precede those which are more advanced. In other cases well known authors and titles which have long been recognized as standard are placed first. In some instances priority has been given to more recent publications, assuming that they have the advantage, if no other, of being up to date.

"The letters following the names of authors refer to publishers, as shown on the table on the last page, which includes all publishers who have three or more titles in the list."

ACCOUNTING.

Bookkeeping, Auditing and Accounting—William Morse Cole [illegible]
Bookkeeping, Accounting and Auditing—T. H. Russell and W. L. Jeckman [illegible]
Bookkeeping and Accounting—J. J. Klein—A [illegible]
Bookkeeping for Accountant Students—Lawrence R. Dicksee—G. [illegible]
Modern Accounting: Its Principles and Some of Its Problems—Henry Rand Hatfield—A [illegible]
The Applied Theory of Accounts—Paul Joseph Esquerré—R [illegible]
Accounting Theory and Practice—R. B. Kester—R [illegible]
Accounts—Their Construction and Interpretation—William Morse Cole—HM [illegible]
Principles of Accounting—John Raymond Wildman [illegible]
Science of Accounts—Harry C. Bentley [illegible] 393 pp
Corporate Finance and Accounting—[illegible]
Corporation Accounting—R. J. Bennett—R [illegible]
Principles of Accounting—[illegible]
Elements of Accounting Theory and Practice—[illegible]—A [illegible]
Accounting Practice and Procedure—Arthur L. Dickinson [illegible]
[illegible]
Accounting in Theory and Practice—George Lisle—R [illegible]
The Philosophy of Accounts—Charles E. Sprague—R [illegible]
Advanced Accounting—Lawrence R. Dicksee—G [illegible] 155 pp
[illegible]
Net Worth and the Balance Sheet—H. G. Stockwell—R.... [illegible]
[illegible]
[illegible]
[illegible]
[illegible]
Ancient Double-Entry Bookkeeping—John B. Geijsbeek [illegible]
[illegible] 254 pp
[illegible]
[illegible]
[illegible]

[illegible]
General Information on the Georgia C. P. A. Examinations [illegible]
[illegible] 27 pp.
[illegible]

COST ACCOUNTING.

Cost Accounting and Burden Application—Clinton H. Scovell—A [illegible]
[illegible]
Factory Costs—Frank E. Webner—R [illegible]
[illegible]
[illegible]
[illegible]
Manufacturing Costs and Accounts—A. Hamilton Church—M [illegible]
Industrial Organization, Systematization and Accounting, 3 Vols.—Clinton E. Woods [illegible]
[illegible]
[illegible]
[illegible]
Principles of Factory Cost Keeping—Edward P. Moxey—R. 102 pp
[illegible]
Cost Keeping for Manufacturing Plants—Sterling H. Bunnell—A [illegible]
[illegible]
[illegible]
[illegible]—M. [illegible]
Cost Keeping and Management Engineering—Halbert P. Gillette and R. T. Dana—M. [illegible]
[illegible]
[illegible]
Fundamentals of a Cost System for Manufacturers—Federal Trade Commission [illegible]
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ABBREVIATIONS

A—[illegible]
AH—Alexander Hamilton Institute, New York
D—Doubleday, Page & Co., New York
E—Industrial Management, New York
[illegible]
[illegible]
[illegible]
HM—Houghton Mifflin Company, Boston
[illegible]
[illegible]
M—McGraw-Hill Book Co., Inc., New York
[illegible]
[illegible]
S—The A. W. Shaw Co., Chicago
[illegible]
W—John Wiley & Sons, New York
[illegible]
o. p.—Out of print.
Note: Obtainable only by subscription to entire course.

Water Laws of Oregon.—[illegible] organization of irrigation, drainage, diking and improvement [illegible] Court or the Supreme Court of the United States.

Block System of Handling Water Consumers' Accounts at Milwaukee, Wis.

As a result of the new system of reading meters and handling customers' accounts placed in operation last June by the Water Department of Milwaukee, Wis., a great deal of duplication and unnecessary work by meter readers and bookkeepers has been eliminated. The following description of this and the results obtained from it is abstracted from the recently issued report for the year ending Dec. 31, 1918, of H. P. Bohmann, superintendent of waterworks.

By this plan the city is divided into two general subdivisions with Wisconsin St.—Grand Av. as a dividing line. The entire portion of city north of this general subdivision line is divided into blocks comprising one or more city squares each and each block containing approximately 100 accounts. Blocks are numbered in parallel lines from east to west, with odd numbers only. 100 numbers being allowed to each parallel line.

For example: Blocks in first parallel line above or north of Wisconsin St.—Grand Av., are numbered 1, 3, 5, 7, etc.; blocks in second parallel line are numbered 101, 103, 105, 107, etc. The portion of city south of the general subdivision line is divided into blocks and numbered in same manner as northern portion. All blocks carry even numbers. Block numbers, therefore, are permanent, and do not change. All consumers' accounts in each individual block are numbered consecutively from one up, beginning at a common starting point in each block.

For facility in handling work at the office the city is divided into nine equal parts or sections, beginning at the lake shore and radiating wedge-shaped to the outskirts. One senior clerk-bookkeeper is assigned to each section, with complete charge of all accounts therein. The advantage of this arrangement is that it distributes the work equally among the senior clerk-bookkeepers, as each section contains part of the down-town or business district, part of the central and part of the outlying district.

All consumers' ledger cards were renumbered and set up in accordance with the plan outlined above. All inspectors of water meters route slips were renumbered and set up in route books to conform with ledger cards.

Meters are read as set up in route books. During the final months of quarters, when readings of accounts in route books are taken, instead of inspectors of water meters being obliged to make abstracts from books on quarterly reading slips, which in turn had to be delivered to office and assorted and given to clerks in charge, they simply turn in their books and assessments are computed directly from field reports, avoiding a multitude of errors.

When one or more blocks are computed the senior bookkeeper can immediately proceed with preparation of assessment roll, instead of waiting until all readings were in and all accounts computed as according to connection number plan. Billing can be begun by clerks immediately after the first day's readings are in and accounts computed, instead of waiting until all readings were taken and inspectors of water meters reported at the office to do billing.

Under the new plan when all readings are taken and accounts computed and billed, bills are in the same rotation as ledger cards and route book accounts and are immediately ready for delivery. All time required for assorting bills for delivery has been eliminated. Time required under old system for inspectors of water meters to fill in daily reading slips, detailed daily work report, billing, assorting bills, etc., is now put in on routes taking readings that they were obliged to omit.

All billing at the office now is done by especially constructed machines. By these machines present reading, previous reading, consumption and amount are printed on the bill, as well as amount printed on stub. The amount is set in and printed on bill and the machine automatically shuttles over and prints amount of stub without again setting in figures on machine. Further, the machine accumulates the consumption and the amounts.

These machines have proven very satisfactory for the following reasons:

Bills can be more expeditiously filled in, in fact, increasing the output more than 100 per cent over billing by hand.

A much neater and more legible bill is produced than when written by hand. Where 36 men are writing bills, you have 36 kinds of chirography, with a certain percentage always difficult to decipher by receiving tellers.

As the cubic feet are accumulated, it is unnecessary to again go over accounts to pick up the same for monthly report to general office. Eliminating that extra work.

As amounts are accumulated all time for running bills on adding machines to check with assessment roll has been saved.

As amounts on bill and stub are printed from same type with but one setting in on machine, all errors between bill and stub, by transposition or otherwise, are eliminated, and all time for comparing bills and stubs saved.

With upwards of 65,000 accounts a very great saving of labor has been shown by these machines.

The section, block and account number system for handling consumers' accounts has now (Dec. 31, 1918) been in operation for one-half year, during which time it has exceeded all expectations and shown a tremendous elimination of unnecessary and duplication of work, in addition to showing a very substantial saving of labor, stationery and postage. Were the collection division operating under the old connection number system an addition to the field force, of at least two men, would be necessary during the year 1919, amounting to an increase in the payroll of upwards of $2,000.

Notwithstanding the fact that the number of consumers is continually increasing, under new plan the present field force will be ample to handle the work of the division during next year.

It is probable that the elimination of unnecessary and duplication of work will amount to several thousand dollars annually and the saving of labor, printing and postage after all deductions and offsets an equal amount annually. The system moreover, furnishes the proper control over field men.

How Can I Solve This Economic Problem?

When one executive has a particularly perplexing problem to solve, he takes out of his drawer a "cross analysis sheet." On this sheet he writes the problem to be solved. Putting it down on paper seems to bring it that much clearer to his mind. Then he lists every element, every factor, entering into the problem. By the time he has put them all down, the problem is in a fair way to solve itself, writes F. M. Swan in System.

For example, the sheet is divided into five columns. One column is headed "things to think about"; the others, in succession read: "to save space," "to save time," "to save material," "to save energy." There are 21 horizontal spaces. In each space appears a question, under the heading, "Things to think about." The questions are:

1. What elements are alike?
2. What are different?
3. What is the unit?
4. Are there many units?
5. Can units be grouped?
6. Can groups be multiplied?
7. Can position be changed?
8. What is the limitation?
9. Can reuse be applied?
10. What is the exceptional?
11. What is the general?
12. Can factors be eliminated?
13. Will use of symbols help?
14. Will an outside influence help?
15. Will motion study help?
16. Must force be considered?
17. Is or can there be rhythm?
18. What is the order of progression?
19. What are the common errors?
20. What will it cost?
21. What will it be worth?

Opposite each question the executive writes his answer in one or more of the four columns—to save space, time, material, and energy. If the executive cannot satisfactorily answer most of the questions, he knows that the solution he has in mind is inadequate. Thus he eliminates all loss from wrong experimenting.

The main advantage of the sheet is its suggestive value—it permits no aspect of the problem to be missed; and the impulse given by the sheet to think about every aspect usually results in some good ideas for handling the problem.

Cost of Thawing Water Services at Council Bluffs, Ia.—During the winter of 1917-18 the Water Department of Council Bluffs, Ia., thawed 31 services at an average cost of $5.14 per service. Eight 2 in. mains were thawed at an average cost of $10.27 per block.

POWER AND PUMPING SECTION

This section of the Waterworks and Hydraulic Monthly issue of Engineering and Contracting is devoted to the selection of power and pumping equipment and the economic management of its operation.

Horsepower Requirements of Centrifugal Pumps

The water horsepower requirements of a centrifugal pump may be easily determined when the quantity to be pumped and the total head are known. However, it is necessary to have some idea of the efficiency of different sizes and kinds of pumps before the actual horsepower for the driving motor can be specified. Useful information on this subject is given by Mr. T. M. Heermans, Mechanical Engineer, Centrifugal Pump Department, Allis-Chalmers Manufacturing, in a recent issue of Power from which the matter following has been taken.

The efficiencies in the accompanying table are conservative and can be used in estimating the horsepower required for well-designed pumps operating at suitable speeds against moderate heads.

CONSERVATIVE EFFICIENCIES FOR PUMPS OF VARIOUS CAPACITIES.

Size of pump. In.	Normal capacity, G. P. M.	Efficiency single-stage heads up to 150 ft. Per cent	Efficiency multistage heads above 150 ft. Per cent
2	100- 150	50	45
3	200- 350	55	[illegible]
4	400- 600	60	56
5	650- 900	65	[illegible]
6	950-1,300	70	68
8	1,500-1,800	72	[illegible]
10	2,000-3,000	75	[illegible]
12	3,500-4,500	76	[illegible]
14	5,000-6,500	77	[illegible]
16 and over	..	78	[illegible]

The usual practice in fitting motors to centrifugal pumps is to allow 10 per cent leeway over the horsepower that it is figured will be required.

Besides knowing the size of motor to put on a pump, it is necessary also to know something about the starting requirements of centrifugal pumps and how they affect the selection of the type of motor and also the starting apparatus to be used. Centrifugal pumps are started up quite easily and are generally considered "light starting duty for a motor." Consequently, squirrel-cage motors, and even synchronous motors that do not have much starting torque, can be used to drive centrifugal pumps, but this statement needs a little explanation. The curves of Fig. 1 are typical of the performance characteristics of three different types of centrifugal-pump runners. Chart A is for a standard single-stage centrifugal pump fitted with a runner having a rising horsepower characteristic. By slightly changing the runner design, this pump can be made to have a horsepower curve that is practically flat from the point of maximum efficiency on. Chart B is representative of the ordinary type of multistage pump with diffusion vanes, and chart C shows the characteristics of a single-stage pump with a so-called Francis type runner which is particularly designed so that relatively high pump rotative speeds can be employed for low heads. These curves have been reproduced to show in particular the "shutoff horsepower" of different kinds of pump runners. This is the power required to rotate the pump runner at rated speed in the pump casing when full of water but when no water is allowed to be discharged, as would be the case when the pump is started up with the valve in the discharge from the pump closed. The shutoff horsepower has been indicated as a certain percentage of the horsepower required at the highest point of the curve, which has been taken as 100 per cent.

Slip-ring or shunt-wound direct-current motors will start pumps having the characteristics shown by all three curves, and squirrel-cage motors also have been found capable of starting these pumps, although in the larger sizes and sometimes for pumps having the characteristics shown by chart C, squirrel-cage motors will take too much current in starting to be used. Standard synchronous motors will [illegible] start pumps having the characteristics of chart A, and develop the necessary torque to pull into synchronism when up to speed, but will have to have specially constructed motors to develop the 50 per cent of rated horsepower required to pull pumps having the characteristics of chart B into synchronism, and cannot be used at all, except by making special arrangements to start pumps having the characteristics shown in chart C.

The special arrangement just mentioned is to equip a pump so it can be started up empty and then primed after being brought up to synchronous speed. What is done is to provide some means of lubricating the close clearances in the pump until it can be primed, when the water will provide the lubrication. The necessary attachments can be made [illegible] on single-stage pumps, but it is rather difficult to fit up the multistage type. For this reason they are seldom started up empty, although clutches are sometimes employed.

As the present [illegible] up with a closed valve in the discharge. As a general rule [illegible] will be much worse. It is necessary only to refer to the curves again to see that where no discharge valve is provided, the motor in coming up to speed has also to come up to full [illegible] of at a fraction of full horsepower. This is not good practice and is bad for the motor even if undue disturbances will not be caused in the line. Instances have been known where the [illegible] attached to centrifugal pumps without any valve in the discharge have in time loosened up the motor coils.

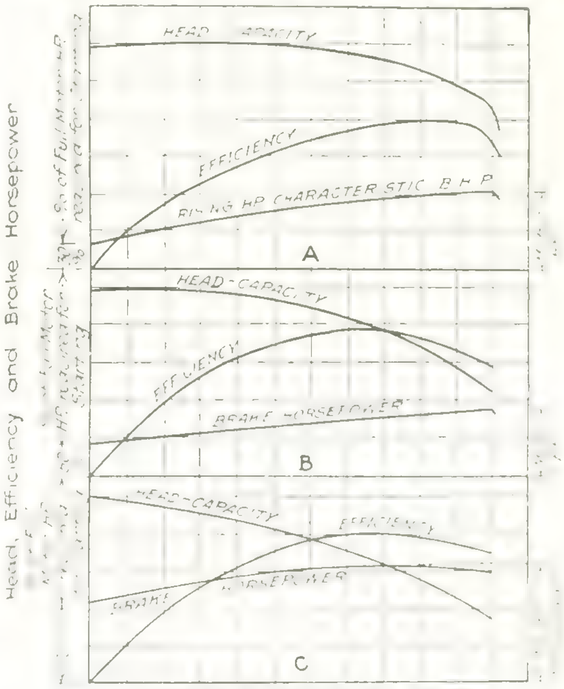


Fig. 1—Pump Characteristic Curves

Having considered the power required to start and operate centrifugal pumps, brief reference will be made to the kinds of motor used for pump drive. This is a large subject in itself and will be taken up in detail in succeeding articles. Probably the motor most commonly used to drive centrifugal pumps is of the squirrel-cage induction type. This motor, on account of its simplicity and also because the starting duty of a centrifugal pump is not heavy, is used to drive the majority of small and moderate-sized pumps.

In sizes over 150 hp. and in many cases less, the slip-ring induction motor is used instead of the squirrel-cage type, because it takes less current from the line in starting. Also power companies often fix the maximum size of squirrel-cage motor they will allow to be connected to their lines. In still other cases where a system does not have much capacity, throwing a large squirrel-cage motor on the line would cause serious disturbances and possibly a voltage drop that would be enough to prevent the motors coming up to synchronous speed. These cases call for the use of slip-ring motors. This type is used sometimes when a moderate amount of speed control of the pump is required, possibly to maintain a constant pressure with a variable discharge or to maintain a constant discharge with varying heads.

Direct-current motors as well are used where speed variation is required, but for constant-speed service are not used so much as induction motors. Then, too, for moderate heads standard centrifugal pumps ordinarily run at higher than the best direct-current motor speeds. However, relatively high-speed direct-current motors are now being built that can be used as satisfactory pump drives where only direct current is available.

As a fourth kind of pump drive synchronous motors are just beginning to receive deserved attention. Many centrifugal pumps, because they offer a constant steady load, present a fine opportunity for using a large synchronous motor to keep up or correct the power factor of a power system, and by using proper care suitable synchronous motor-driven centrifugal pumps can be often selected.

Before leaving the subject of the horsepower requirements of centrifugal pumps as related to motor drive, possibly it will be well to point out a few troubles that are sometimes encountered with motors and that are traceable to the centrifugal pump. The most common difficulty, which has been mentioned previously, is operating an improperly selected pump at less than the rated head. This will overload the motor and cause it to run hot. Another trouble almost as common is pump and motor out of alignment due to improper erection. This causes vibration and hot bearings and wears out rapidly the coupling bushings. A third trouble sometimes experienced and resulting in hot motor bearings, is when the centrifugal pump develops an end thrust, causing collars on the shaft to rub on the ends of the bearings. End thrust may develop in a single-stage double-suction pump on account of one side of the runner becoming partly obstructed or an obstruction lodging in the suction passage on one side, which unbalances the runner. Unequal wear of the runner wearing rings on opposite sides of a double-suction runner or displacement of the runner slightly to one side of the center line of the casing also will cause thrust. In multi-stage pumps thrust is generally caused by failure or partial failure of the arrangements provided to balance the end thrust. Two pumps taking their suction from the same suction pipe or discharging into the same discharge line, if they are not properly arranged and do not have the right kind of characteristics, can cause trouble by dividing the work unequally, but this and similar questions are outside the scope of this article.

It can be safely stated that a pump should not be bought merely as a pump of a certain size without any reference to the work it will have to do. In conjunction with the driving motor it should be selected to do certain definite work to the best advantage. It is therefore preferable to buy pumps that have been tested carefully and their characteristics determined, with motors of suitable size to run the pumps under all the conditions that will be met with in service. That is, a pump and the drive should be considered as a unit and selected accordingly.

Water Consumption at McPherson, Kans., in 1918.—The daily consumption of water at McPherson, Kans., in 1918, was 77 gal. per capita, or 350 gal. per consumer. The total number of consumers was 1,025, an increase of 34 over the previous year. The total population in 1918 was 4,500; in 1917 it was 4,200. Comparative figures for the two years on total income from sale of water follow:

	1917	1918
Total income .	[illegible]	[illegible]
Per capita	[illegible]	[illegible]
Per consumer	14.75	14.88

34 Boiler Room Pointers

The little notes that follow contain suggestions that will be of service to everyone interested in power plant engineering. The pointers were selected by the editors of Power from the columns of that magazine.

(1) A boiler should be considered as composed of two distinct parts—a furnace wherein fuel is burned to produce heat, and a shell or vessel containing water to absorb the heat produced. The furnace efficiency may be the maximum obtainable and yet the overall efficiency of the boiler be low because of scale and soot on the heating surface; the heating surface may be clean and capable of the most rapid transfer of heat, yet because of unsuitable fuel, plugged air spaces in the grate, leaky furnace walls and doors, the overall efficiency may be low.

(2) A pound of pure carbon requires 11.6 lb. of air for complete combustion. As coal is not all carbon, but contains a variety of ingredients, all of which vary in different coals, from 20 to 40 lb. of air per pound of coal is required. The difference between the theoretical quantity and the quantity practically needed is the "excess quantity," or "excess air," as it is called. "Too much excess air," then, means more than the quantity practically needed.

(3) The sampling pipe through which passes the flue gas collected for analysis should be placed in the most active part of the gas flow. A good way to tell that you have the pipe in the right place in the uptake at the damper on the boiler side is to move it in and out across the gas path, analyzing samples collected at each position; the point where the quality of the gas varies most widely in a given time is the correct place for the sampling pipe.

(4) To reduce the maintenance cost of furnace lining in stoker-fired, forced-draft boilers, a high-grade firebrick is used up to the fire line; a bauxite brick is commonly employed for this purpose.

(5) Solutions for the Orsat may be made as follows: For oxygen, put 1 oz. of pyrogallic acid (powder) into a quart of water, pour in a pint of caustic solution (see solution for CO_2) and immediately seal the bottle air-tight until used. For CO_2, dissolve 1 lb. of caustic potash in 2½ pints of water. for CO, acid cuprous chloride is used. Put a ½-in. layer of copper oxide in the bottom of a quart jar. Put in a bundle of a dozen lengths of No. 10 or 12 gage bare copper wire cut to length a little less than the depth of the jar. Fill the jar with hydrochloric acid, seal and shake occasionally for 48 hours. Pour off the clear solution and seal it.

(6) Coal ash contains silica, alumina, iron pyrites and other mineral matter. Depending upon the chemical composition and physical condition, these cause the ash to fuse more or less easily. The temperature at which firebrick will melt is sometimes influenced by the composition of the ash. For instance, a certain ash might melt at 2,600° F. and a certain firebrick at 2,800° F.; but together in a furnace where the ash and the brick make contact, both might melt at 2,500° F.

(7) Leaky boiler settings may be made lastingly tight by soaking cheap waste or asbestos from old discarded pipe covering in thin fireclay and hammering the mixture into the cracks. Paint the brickwork with thin fireclay or cement.

(8) Experience has shown that the loss occasioned by excess air rushing in at the rear of a chain-grate stoker when that part of the fuel bed is kept thin to burn out the last trace of combustible in the ash is greater than the gain made by burning the combustible. A coal high in ash, therefore, is well suited to this type of stoker.

(9) Seldom does a fire burn uniformly over the whole grate area; holes will form. When covering, fill these holes level before putting coal on the rest of the fire and keep the whole fuel bed even.

(10) An underfeed stoker is able to smokelessly burn even high-volatile coals, because when the volatile is distilled it must pass through the hottest part of the fuel bed before getting out into the furnace. Besides a sufficiently high temperature, the only other chief requirement for the proper burning of the volatile is time, just as it takes time for a cake of ice to melt at summer heat.

(11) The furnace temperature must be kept high enough to combust the gases, but must not be so high as to melt the ash.

(12) Sometimes where a long combustion arch or horizontal baffling is used and is close to the fire, the furnace

temperature melts the ash, causing the slag to fill up the space in the grate, reducing the available boiler capacity. If a water-tube boiler, exposing the first row of tubes by putting the tile between the first and second rows will usually reduce the temperature sufficiently to avoid trouble.

(13) To build a new fire with a minimum of smoke when bituminous, high-volatile coal is used: Put a thin layer, say 2 in., of green coal on the grate and cover with shavings and wood soaked in crude oil or its heavy distillates. Ignite and put on as little green fuel as possible, the aim being to begin the fire by burning the top of the layer, thus making the volatile gases and vapors pass through the hottest zone; keep the fire-door open as much as needed to prevent smoke.

(14) The Boiler Code of the American Society of Mechanical Engineers gives the following formula for finding the safe working pressure of a boiler:

$$\frac{TS \times t \times E}{R \times FS} = \text{working pressure, lb. per sq. in.}$$

where

TS = Tensile strength;
t = Minimum thickness of shell plate, in.;
E=Efficiency of longitudinal joint or of ligaments between tube holes (whichever is least);
R Inside radius of weakest course of shell, in.;
FS=Factor of safety.

(15) In making a hydrostatic test on a boiler in service (not a new boiler) the same code states that the test pressure shall be one and one-half times the working pressure. During such tests the safety valve or valves must be removed or each valve disk held to its seat by a testing clamp and not by screwing down the compression screw upon the safety-valve spring. The Massachusetts rules also specify one and one-half times the maximum allowable working pressure when making a hydrostatic test.

(16) The safety-valve capacity on a boiler should be such that the valve or valves will discharge all the steam that can be generated by the boiler without allowing the pressure to increase more than 6 per cent above the maximum working pressure or more than 6 per cent above the highest pressure to which any valve is set.

(17) Safety valves have blowdown or huddling rings for adjusting the blowdown. If a valve opens at the correct pressure, but does not close until the pressure has dropped, say 5 lb., instead of the usual 3 lb., the huddling ring needs adjustment.

(18) A fusible plug should always be placed in the direct path of the gases, should project into the shell at least 1 in. or into a tube at least ½ in., it should not be less than ⅜ in. diameter of fusible metal. The amended Massachusetts rules say that the body of the plug must be of bronze, reamed and tinned before being filled and filled with 99 per cent pure tin. These same rules say that no fusible plug shall be used for a longer period than one year. Always keep scale off a fusible plug.

(19) Experience seems to have shown that parts of a boiler that are in stress corrode more rapidly than parts not in stress.

(20) One of the most satisfactory explanations of the mechanism of a boiler explosion is known as the Colbrun Clark theory and, briefly, is as follows: An initial rupture; sudden, rapid reduction in pressure, the formation of a great quantity of steam in the water, hurling the water at the opening, increasing the latter and shattering the boiler; completion of vaporization of the liberated water, projecting the parts to distances depending on the violence of the expansion.

(21) For high pressure, say 100 lb. and over, the blowoff pipe should be extra heavy, should have a valve and a cock at the boiler or mud drum and should continue to the main blowoff line or tank without reducers.

(22) Every care should be taken to keep all high-pressure steam lines drained of water all the time. Water-hammer is dangerous and often responsible for fatal accidents and serious damage.

(23) The most generally accepted theory of corrosion is the electrolytic theory, according to which one spot in a piece of metal is electro-positive and another electro-negative. Moisture or water connecting the two spots completes a circuit, causing a flow of electricity from one to the other, the metal going into solution at the place from which the current flows. There are many hundreds of these spots on a small area, so pitting is the result.

(24) A very thin coating of scale on a boiler not run at extremely high rating prevents rapid corrosion if the water is corrosive; but where very high ratings are used, the transfer of heat is often not rapid enough through the scale to prevent bagging the tube or shell.

(25) The Manchester Steam Users' Association, England, some years ago made tests to explode or rupture an overheated boiler by putting cold feed-water into it. The results of these experiments have convinced many that merely admitting cold water to an overheated boiler will not of itself explode the latter.

(26) Carbonates of lime precipitate out of water heated [illegible] in an open heater [illegible] to 270° F. before they will precipitate by heat alone.

(27) When the capacity of an injector decreases slowly, say week by week, it indicates that the combining tubes are becoming coated with scale. Soaking the tubes or injector in a strong soda solution will help loosen the scale.

(28) In cases of foaming reduce the furnace temperature by checking the draft or by shutting off the fuel supply if oil or gas is used. Throttle the steam line if possible. These should stop it unless something is radically wrong, which must be determined by shutting down the boiler.

(29) For economical and reasonable smokeless combustion in boilers, especially at high rates of combustion, the furnace volume and distance from the fuel bed to the heating surface should be considerably greater than was common until a few years ago. Where the coal contains much volatile, say from 12 per cent up, the distance from the grate to the shell or tubes should be at least 48 in., and for stoker-fired, forced-draft conditions, at least 60 in.

(30) When two or more blowoff lines discharge into a main, always be sure that the blowoff valves and cocks are closed on idle boilers in which men are working or likely to work. Otherwise injury or death may result when line boilers are blown down, owing to water and steam backing into the idle boiler or boilers.

(31) An automatic stop valve is just as much a necessary safety device for a boiler as a safety valve. And an automatic valve doesn't cost over 5 per cent more than an ordinary stop valve of like size. Then considered as safety insurance the investment in a good automatic valve for each boiler is about as much for the money as could be had in most any other way.

(32) The greatest care must be taken in cutting a boiler in on the line with others in service. When the pressure is the same as the line pressure and with the piping and valves drained of all water, crack the stop valve, and if everything sounds good, slowly open the valve until fully open. An observer at the gage should say when the pressure is equal.

(33) It is always good practice to use tees or crosses instead of elbows in bends in the feed-piping, so that the pipes may be easily washed and cleaned.

(34) C. E. Stromeyer, chief engineer for the Manchester Steam Users' Association, in his "Memorandum" for 1915 says about laying up a boiler: "To prevent internal corrosion in idle boilers these should be emptied and dried, trays of unslaked lime should be placed inside, and all manholes and other openings should be hermetically sealed. The lime will soon absorb any moisture, carbonic or sulphurous acid that may be in the boiler, and any remaining salt or chloride of [illegible]

Water Sales at Concord, N. H., Total $2,300,000 in 46 Years.

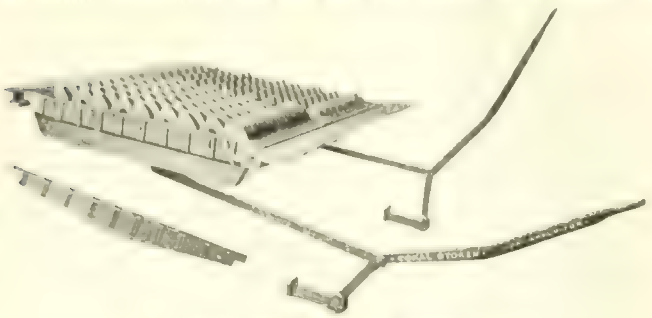
The total receipts from the waterworks of Concord, N. H., [illegible] were constructed in 1872. The receipts for the first year of operation ending Jan. 31, 1874, were $4,431. The receipts for 1918 were $78,077, the highest for any year of the period except 1915, when they were $78,940. The net cost of the works [illegible]

Report on Surface Water Supply of New Mexico.

[illegible] New Mexico has been published by James A. French, State Engineer, Santa Fe, N. Mex. This report is the seventh of a series containing the results of stream gagings on New Mexico streams, said series covering eight calendar years, from 1911 to 1918, inclusive.

Self-Cleaning Stoker That Burns Coal by Coking Method

A self-cleaning stoker that is claimed to effect unusual economies in fuel consumption is illustrated. The coking method of firing is employed with this stoker, which results in nearly smokeless and very economical combustion of coal. In firing the coal is piled just inside the fire doors. The gas from the coal is consumed in passing over the hot coke at the rear of the furnace. When the gas has been driven from the coal the entire contents of the fuel bed are moved back toward the bridge wall, after which additional coal is placed at the front of the stoker to be coked. The ash, refuse and clinker is dumped at the back of the stoker through a 5 in. opening into the ash pit. The stoker eliminates the necessity of cleaning fires by the use of slice bars, hoe or other firing tool. It also is claimed to maintain a uniformly even firebed, thus doing away with the waste of fuel caused by air holes in the fire. This stoker is made by the CoKal Stoker Co., 1023 North Clark St., Chicago, Ill.



CoKal Self Cleaning Stoker.

New Motor of Hvid Type

The Pittsburgh Filter & Engineering Co., formerly the Pittsburgh Filter Manufacturing Co. of Oil City, Pa., has begun the manufacture of a new type "M. V." heavy-duty marine oil engine. The engine embodies the well-established and successful method known in Europe for many years as the Brons principle, and in the United States as the Hvid principle. The motor is entirely independent of any carbureter, hot bulb or plate, spark plug, high pressure air compressor and storage tanks, fuel pump or spray valve. The compression is carried to approximately 500 lb. per sq. in. and the motor is started from cold without pre-heating and put under full load in a few seconds. These motors will burn any grade of the cheaper fuels, from kerosene to the heaviest of fuel oils, the same fuel serving for starting the motor. The engine is of the inclosed type and the design has adhered as far as possible to the thoroughly tested practice of modern high-speed Diesel engines. Not only is the crankcase inclosed, but the camshaft bearings, roller levers and gears run in a bath of oil. The camshaft can be removed by taking off the front cover. Accessibility of the crank pins is provided by very large openings in the crankcase. Air to the cylinders is admitted through slotted mufflers. Exhaust ells and header are water-jacketed.

Cost of Thawing Water Services at Taunton, Mass.—During the first week of January, 1918, the Water Department of Taunton began to have frequent calls to thaw services and remove frozen meters. Two trucks were fitted with apparatus and electricity from the Municipal Light Department was used wherever possible. The apparatus on each truck consisted of a transformer, a switchboard and a barrel of salt water in which were immersed iron plates. One transformer had a capacity of 2,300-220 Volts and the other 2,300-110 volts. About 450 services were frozen, a little less than 8 per cent of those in use and in addition about 2,000 ft. of 6-in. main and 2,000 ft. of 8-in. main. Generally the mains damaged were those in which there was no circulation, or what we designate as dead ends. There were no hydrants frozen but the branches to several were. About 500 meters were burst or about 14 per cent of those in use. The cost of thawing the services with hot water was $4.80 each and with electric current $5.50 each. The Water Department paid the Light Department $700 for electricity and $1,080 for services of men, use of wires and incidental expenses. The cost of the damage to meters is hard to determine, but it is estimated to be at least $4 for each meter taken out. The expense of thawing and the expense of removing, repairing and replacing meters does not cover the expense occasioned the department by the cold weather. Leaks have been developing from that time up to the present and probably will continue for months.

Cost of Garbage and Refuse Collection at Columbus, O.—The Division of Garbage and Refuse Collection of the city of Columbus, collected 1,542 tons less garbage in 1918 than in the previous year, according to the last annual report of E. W. Stribling, Superintendent of the Division. The amount of garbage produced per capita in 1918, was 138.93 lb., 1917 per capita 156.11 lb., a decrease of over 17 lb. per capita. During 1917 and 1918 garbage was collected once each week. In previous years garbage was collected once per week in all months except July, August and September, when same was collected twice a week. The average number of teams employed each week through the year was 22. The average number of loads collected by each team daily was two, excepting the hotel teams, which made from two to four loads. The average weight per load was 1.13 tons. The division collected 15,630 tons. The cost of garbage collection was $58,254, an increase of $9,192 when compared with the cost of collection in 1917. The cost of collection per ton was $3.633, an increase of $0.841 when compared with the 1917 cost. One item that enters largely into the cost of garbage collection is the freight charge paid to the Hocking Valley Railway Company for transporting the garbage from the unloading station to the reduction plant. The cost of freight on each ton of garbage collected was $0.227. If this cost was deducted from the total cost of collection per ton, which was $3.633, it would show a cost of $3.406 per ton for each ton of garbage delivered at the unloading station. There were collected 33,305 loads or 169,186 cu. yd. of rubbish and ashes. The decrease in yards from 1917 was 3,275, or approximately 2 per cent. The cost of rubbish collection was $87,492, an increase of $14,200 when compared with the 1917 cost. The cost of collection per yard was $.516, an increase of $.095 when compared with the 1917 cost.

Personals

H. V. Hennen has been appointed city manager of Denton, Tex.

Harry Bollinger has been appointed city engineer of Columbia City, Ind.

Henry Sheack has been appointed manager of public utilities of Newton, Ia.

Leorard L. Ryan has been appointed city manager of McCracken, Kan.

G. L. Fugate has been appointed assistant city engineer of Houston, Tex.

C. C. Duggan has been appointed superintendent of water works of Paris, Tex.

C. J. Renner of Mount Vernon, N. Y., has been appointed city engineer of Ellwood City, Pa.

Charles O. Ephlin, at present county commisisoner, has been appointed city manager of Wheeling, W. Va.

Lieutenant Colonel George A. Johnson and Major Webster L. Benham have formed a partnership for a general consulting engineering practice under the firm name of Johnson & Benham, offices at 150 Nassau St., New York City, and Firestone Building, Kansas City, Mo.

H. I. Reid of Colorado Springs, H. S. Sands of Denver, R. J. Grant of Denver and Frank E. Shepard of Denver have been appointed engineer examiners by the governor of Colorado. All engineers practicing in the state under an act of the legislature must obtain licenses from the board before practicing. State Engineer A. J. McCune is ex-officio member of the board.

Industrial Notes

The McMyler Interstate Co., of Cleveland, O., has opened a branch office in San Francisco with L. A. Somers in charge. Mr. Somers is an engineer of considerable prominence, having been associated, in the capacity of sales manager, with various large companies. The office will be located in the Merchants' Exchange Bldg. and is intended to serve the state of California and the western part of Nevada.

J. W. McCabe, who until recently has been district manager of sales for the Chicago Pneumatic Tool Co. at Buffalo, N. Y., has been appointed special representative for the company's foreign trade department and will depart shortly for an extended trip throughout the Orient, Philippine Islands and Australia. W. H. White has been appointed acting district manager of sales at Buffalo in charge of that territory during Mr. McCabe's absence.

The H. W. Clark Co., of Mattoon, Ill., manufacturers of the Clark Meter Box and allied lines of water works materials, now occupies its new factory just completed at Mattoon. It will be remembered that the Clerk Co.'s plant of over 45,000 sq. ft. of floor space was completely destroyed in a tornado of May 6, 1917. Since then and prior to removing into the new plant this company has been operating in temporary quarters with a foundry located in Shelbyville, and its other allied departments operating in Mattoon, Ill. The new plant comprises an engineering and drafting department, pattern shops, gray iron foundry, brass foundry, blacksmith shops, machine shop, sheet iron works and nickel plating plant. It is located on two spurs from the Illinois Central Railroad and is supplied with two tracks, one for incoming material and the other for outgoing finished products.

Railways and Excavation Monthly Issue

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The *articles* in the first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering and contracting field. The *articles* in the first and last issues of each month (1st and 4th Wednesdays) completely cover county engineering and highway engineering and contracting. The *articles* in the third and last issues of each month (3rd and 4th Wednesdays) completely cover steam and electric railway location, design and construction. See the "mast head" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads   (c) Street Cleaning
(b) Streets   (d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks   (c) Irrigation and Drainage
(b) Sewers and Sanitation   (d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation and Dredging   (c) Quarries and Pits
(b) Rivers and Canals   (d) Railways, Steam and Electric
(e) Management and Office System

Buildings and Structures—4th Wednesday
(a) Buildings   (c) Harbor Structures
(b) Bridges   (d) Miscellaneous Structures
(e) Properties of Materials

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Why an Engineer Should Be Appointed on the I. C. C.

There is a vacancy on the Interstate Commerce Commission. What are engineering societies doing to persuade President Wilson to appoint an engineer to fill the vacancy?

In a recent address E. R. Ripley, president of the Santa Fe Ry., said:

"The Interstate Commerce Commission has been in existence about thirty-two years. It has had many able men in its makeup and many not so able. Some have been appointed because of their political activities, or as a reward for something else. It is singular that it has never had among its members either a railroad man, a business man, a shipper, or a farmer. Once a railroad conductor was appointed, and it is only fair to say that he made one of the best commissioners we have had. There has been a notable absence of men specially educated or trained for the work."

It may be added that no engineer has ever been a member of this great rate-making commission; yet nearly all the literature on appraisals and rate-making has been written by engineers. The contributions to that literature from others than engineers have not only been meager but devoid of originality.

Where the literature of a technical subject—such as valuation and rate-making—has become voluminous, only a technically trained man is likely to attempt to master it and keep abreast of its new developments. Hence the great importance [illegible]

[illegible] to the effect that the commission employs engineers, and con- [illegible] that the commission more than once erred in its decisions because it did not consult its engineer in making them. Commissions particularly where composed of lawyers, are prone to think that they have a full understading of technical terms and their significance, when in reality they frequently have either a misunderstanding or a quite incomplete comprehension. We venture to say that not half the rate-making commissioners in America state and interstate could pass an examination on the meaning of two terms that they use re- [illegible]

When will it be generally realized that technical cases should be [illegible] are at least partly tech- [illegible] Peter Grosscup pointed [illegible] rate-making are tech- [illegible] technical courts should [illegible] until technical men, through their organiza- [illegible] dents and governors that this is a fact, we shall [illegible] nical commissions and courts gravely trying to solve problems that are beyond them.

28 Pages = 40 pages

The 28 pages of articles in Engineering and Contracting contain as many words as 40 pages of the size and typography commonly used by other engineering periodicals. Ours is the same size of type and type-page as that of The Literary Digest—easily read, yet giving a large volume of reading matter per page. Our 28 pages of articles would fill 112 pages of the standard 6x9 in. text-book. It would take 10 such books of 580 pages each to hold all the articles printed each year in Engineering and Contracting, to say nothing of our weekly construction news.

How to Overcome the Opposition of Street Car Unions to Conductorettes

The Detroit United Railway Co. requested the labor union to withdraw its objection to the employment of women as conductors, but the union refused to change its attitude.

In New York state a bill has just been passed to "protect conductorettes" by limiting their working hours, but the real object of the bill was to prevent the employment of women as conductors. What will happen to that bill when women get universal suffrage is easy to forecast. But it is not so easy to predict the outcome of the struggle of labor unions to prevent women from acting as conductors. The striking men of Cleveland have succeeded in ousting the women. Evidently Detroit is about to succeed in similar manner.

Several sophistical reasons are given for opposing the employment of women as conductors. The real reason is the desire of men to hold their jobs; and who can oppose that very natural desire? When it is contended that collecting fares on a car is an occupation that women can perform well, men conductors know that the contention is unanswerable; but they also know that they themselves lack the training that would fit them to do better in some other occupation.

The problem seems to simmer down to this: Train street car conductors to do skilled work that will pay them better; and pending their securing the better job, pay them the wages they would have received as conductors. We believe it will not be many years before it is generally admitted that it is a legitimate function of government to train workers and to support them during the training period. When this is done, the opposition of labor unions to women workers will cease; so, too, will their opposition to labor saving machinery vanish. Back of all such opposition now is the dread of losing jobs.

In America the demand for goods and services is illimitable, but we have yet to learn how to shift workers quickly and without friction from one occupation to another. It will be expensive to train workers and to support them during the training, but it has been far more expensive not to do so.

Chicago Milk Drivers Paid More Than Assistant Professors

In addressing the Chicago Teachers' Federation, Prof. J. Paul Goode, of the University of Chicago, said:

"I have not prepared this part of my lecture, but I can prepare it in about a minute. The average milk driver is paid more than any assistant professor in the University of Chicago. A janitor gets more than a school principal. Plumbers get more than teachers. That is because milk drivers and plumbers and janitors have unions.

"More and more of the teachers are forming unions all over the country. There is an average of one union of that kind admitted every day into the American Federation of Labor.

"All honor to the teachers who in the early days were brave enough to come to the rescue of the teaching profession and start federations."

The milk drivers' union in Chicago recently struck to get $35 a week, and got it. Whereupon the milk dealers added a cent a quart to the price of milk, and more than reimbursed themselves for the rise in wages. But underpaid school teachers in Chicago have not been able to get an adequate increase in salaries, in spite of the general admission that they are entitled to it. Much the same condition holds throughout America. Is it to be wondered that one new teachers' union is being admitted daily to the American Federation of Labor?

There has been surprisingly little editorial comment on the new phenomenon of the formation of professional unions that have joined the great labor federation. Most civil engineers have not yet taken seriously the Draftsmen's and Designers' Union, yet they now number more than 5,000 members. Doubtless the teachers' union is still looked upon by most educators as being only a sporadic outcome of war conditions. But is it merely that? We doubt it. From time immemorial teachers have been underpaid. For the matter of that, so have nearly all salaried professional men. The war-engendered rise in prices has merely served to rouse salaried professional men and women to a determination to put an end to a condition of long standing.

Municipal Ownership Experiments with Traction Lines in Two Large Cities

Seattle has purchased a complete street railway system at a bargain, having paid only $15,000,000 for a plant that would cost fully $25,000,000 to reproduce. If Seattle can not make its municipal railway profitable it is a safe bet that no other city can, for Seattle has cheap hydroelectric power, very low priced traction lines, and as clean politics as will be found anywhere. Yet we look to see anything but a profitable outcome.

Seattle is a growing city and there will be incessant demands for extensions of the traction lines into the outlying districts. The city will yield to many of these demands, and will soon learn the meaning of "railway development cost," or the deficit in fair return on the investment in new railway lines. Already "The Industrial Association of the South End" is urging the expenditure of $75,000 for a two-mile extension. Other similar pleas will follow, and it will go hard with the city councilmen who vote against them.

In our issue of May 21, Mr. M. M. O'Shaughnessy, city engineer of San Francisco, charged us with being "unfair and misleading" in an editorial relative to the San Francisco municipal railway lines. His contention is that the "municipal railway is in a healthy and sound financial condition" after 6 years' operation. Mr. O'Shaughnessy failed, however, to prove that the municipal railway earned an adequate return on the investment during the year ending June 30, 1917, which was the last fiscal year for which we had a full report. His contention that street railway companies do not set aside a depreciation annuity, as does the S. F. municipal railway, is not a sound economic argument for regarding a depreciation annuity as superfluous. The fact remains that after deducting tax allowance, depreciation annuity and bond interest there was a deficit of $104,000 for the year ending June 30, 1917.

Mr. O'Shaughnessy has sent us a financial statement for the year ending June 30, 1918, showing a net profit of nearly $108,000 for that year, as compared with the $104,000 deficit for the preceding year. But had 5 per cent interest been paid on the entire investment of more than $6,000,000, instead of on the $5,000,000 bonded indebtedness, the net profit for 1918 would have been only $54,000; yet this was the best year that the municipal lines have yet experienced both as to gross and net earnings.

We repeat, therefore, that the municipal street car lines of San Francisco are not the gold mine that municipal ownership advocates would have us believe.

Municipal ownership should stand or fall on its economic merits. Fortunately we now have two American cities that are experimenting in a large way with municipal street railways. Perhaps Detroit will soon be the third big city to furnish a similar object lesson. We hope so, for we have had enough propaganda and shall welcome real proof as to the economics of municipal ownership of traction lines.

A Lawyer's Definition of Homo Honestus

We have recently printed several new definitions of engineering. Other professions are evidently not satisfied with old definitions either. For example, the Illinois Bar Association recently offered a $25 prize for the best definition of lawyer, and gave the prize to Charles J. O'Connor for the following definition:

"One who masters his case, who gives a fair share of his surplus time to the advancement of jurisprudence, who performs his full duty of citizenship, and who is honest with court, client, opposing counsel, and himself."

We had been led to believe that no profession is so exacting in defining terms as is the legal profession, but this prize definition of lawyer jolts our faith in that tradition. Perhaps it was the jibes of jokers that led Mr. O'Connor to define a lawyer as the species honestus of the genus homo. At any rate here is a 37-word definition of lawyer, half of which specifies integrity as an integral part of every lawyer.

We are reminded of the term by which good whist players designate bad whist—bumblepuppy"; also of the term that good poets apply to poor poetry—"doggerel." Now that a bar association has automatically banned bad attorneys by a definition, perhaps lawyers will more often use that good old word "shyster."

We were about to remark that engineers had not excluded poor engineers from the profession, when we remembered that old technical term, "compass butcher."

What Would Happen Were Street Railway Wages Based on the Rate of Fare?

"The Chicago plan" of co-operation between the street railways and the city has often been referred to as a good solution of a difficult problem. Under that plan the street railways were appraised, and 5 per cent return to capital was allowed. Net earnings in excess of the 5 per cent were divided between this city and the street railway companies. The plan worked well until, as a result of the war, it became necessary to raise wages. Since then there has been nothing but trouble for all concerned.

The companies are suffering a great deficit, the city has ceased to receive any income from the railways, and the employes are alarmed over the prospect of having their wages reduced. The mayor is trying to repudiate the appraisal and is uttering the usual political talk about "watered securities." The state public service commission is showing no desire to raise rates of fare for fear of losing its popularity if not its jurisdiction. All in all, the Chicago traction muddle is about as bad as it could be. Why? Politics.

In the desire to please the public by retaining the nickel fare, politicians may ultimately encounter an unexpected difficulty. Suppose the street railways were to offer their employes a sliding scale wage based on the rate of fare, much as copper producers pay the miners according to the price of copper. Suppose the street railway employes accepted the offer and then struck to force the public to raise the fare to, say, 7 cents. Suppose labor unions were to join in a sympathetic strike. Would politicians then find it popular to continue starving the street railways?

We have been accustomed to think of capitalists and labor unions as being inevitably antagonistic. But may not the antagonism of the public toward public utility companies and railways lead to a defensive alliance between those companies and their employes? If such alliances come into existence, may not the voting power of the employes cause politicians to reverse their present attitude of antagonism to increased rates?

Deferred Maintenance

The maintenance of railway and public utility plants was subnormal during the war, and is far from normal yet. Congress seems to be on the verge of lopping off half a billion dollars from the "revolving fund," leaving only three-quarters of a billion dollars for the railways at a time when there is sore need of funds for maintenance and betterments.

Nearly three-quarters of a million soldiers are to be demobilized before autumn, yet even now there is difficulty in finding jobs for all the "dough boys." It is the clear duty of everyone to lend a hand in the rehabilitation movement. Moreover it will be profitable not to delay maintenance work any longer; for, as Maj. Elihu Church has said, "If while you wait for the price of roofing to come down, down will come the roof."

Railway Surveys and Government Maps

When a new railroad project of any magnitude is under consideration, the engineer in charge necessarily has recourse to maps, even before any reconnaissance is made of the proposed route. First, usually, a small scale map on which a route of perhaps several hundred miles may be taken in at a glance and its location shown with reference to competing and connecting transformation lines; next, a larger scale map on which some of the more prominent features of alignment is shown, together with the approximate [illegible] of stream crossings and other controlling points.

Very seldom has it been in the past that an engineer be [illegible] able any more detailed map than those indicated above. In many cases the best of these have later been found partly inaccurate, especially with reference to the sparsely settled districts [illegible] to 12 miles to an inch and with the streams and tributaries correctly located have proven invaluable to locating engineers who had a general knowledge of topographic forms and their geological origin in the region to be traversed. The back of still better maps, such as small scale contour maps, has often been felt, for these could very well save the work of considerable preliminary field reconnaissance, such as is necessary when the country is at all rough and there is likely to be a choice in routes between consecutive points.

It is undoubtedly well known to the majority of railway engineers that there are map-making bureaus of the national government which publish small scale contour maps of sections of the country as fast as the surveys are completed. The U. S. Geological Survey in particular has been engaged in this map-making as a part of its work for a good many years, but even now has covered but a small proportion of the country. The U. S. Coast and Geodetic Survey also has done considerable mapping. It is a matter of some doubt as to whether railway engineers fully appreciate the use to which these maps may be put where they are available. The scales of the U. S. Geological Survey quadrangles, it will be recalled, are approximately 1, 2 and 4 miles to the inch, respectively, and with a contour interval, commonly, of 20 ft.

A topographic map on a scale of 1 in. to the mile and a contour interval of 20 ft., has enough detail to serve many purposes: A very little study on it will show which of several routes in a general direction is the best; further study will give quite closely the probable grade in feet per mile of this most favorable line and some idea of the alignment and amount of development; condensed profiles may be plotted by scaling from the contours and used for various comparative purposes. Existing lines of railroad already shown on a contour map and probably very economically located for the traffic originally in sight, have been rebuilt and changed somewhat in alignment, and for these changes the contour map has proven invaluable. Drainage areas may be scaled from these maps with sufficient accuracy in many, if not most, cases, to properly proportion the size of waterways, thus saving the expense of [illegible]

In the last annual report of the U. S. Coast and Geodetic Survey, the Superintendent, in making a plea for increased appropriation for the Division of Geodesy, gives an instance of a topographic map having been made by the Geological Survey in the state of Michigan, in co-operation with a certain railroad. As a result of the survey, a gap or pass was found among some hills which permitted the railroad to join two places at a very great reducion of cost over what the expense would have been if it had been necessary to skirt the hilly country or build the road through some pass which was higher in elevation. It was stated by the officials of the railroad that the saving to the company in finding that one pass was much greater than the total cost of the topographic survey. The Superintendent quotes the chief engineer of one of the western railroads as stating that the topographic surveys, as published by the Geological Survey, were of the greatest value, since it was often possible to choose a route between terminal points by reference to the published quadrangles that would be far better than could possibly have been selected had those maps not been in existence. In the extension of the electric railway interurban lines, government contour maps may be of great benefit. The selection of reservoir sites in certain regions, in connection with railroad water supply, has also been aided by small scale contour maps.

The war has stimulated interest in map making and in the use of maps for many purposes. It is believed that in future it will be easier to get generous appropriations from Congress for carrying on Government survey work than it has been in the past, on account of the increased demand for maps. Certainly railway engineers should be interested in the [illegible] completion of [illegible] of the United States, and should lend their support, together with other interested engineers, to the enlarging of this branch of Government work.

The Ideal Shop for Sharpening Drill Steel

Valuable suggestions relative to efficient methods and satisfactory means for the production and upkeep of drill steel were given by Mr. George H. Gilman, Chief Engineer of the Pneumatic Drill and Channeler Department of the Sullivan Machinery Co., in an article in Engineering and Mining Journal. The article, which is reprinted below, is the result of a personal investigation of a great variety of conditions in different sections of the country.

The selection of the best form of equipment to meet a given set of conditions is dependent upon a number of factors, and the extent to which it is profitable to go, in providing facilities for a drill-steel equipment, is largely governed by the volume of material to be handled, which may be determined by the number of rock-drilling machines employed and the character of the ground. In general, it may be assumed that for a mine or other permanent rock-excavating plant of sufficient capacity to warrant the installation of a mechanical drill-sharpening machine a drill-steel plant equipped with the facilities herein described and possessing the following qualifications is warranted.

Primary Requirements of a Sharpening Plant.—Primarily a drill-steel plant having one mechanical sharpener should be designed so that the output of the smith and his helper may be doubled by the addition of two men, without any increase in the original shop equipment being necessary, and to provide for possible growth, it should be so constructed that by adding space and certain features of equipment to one end only of the building the capacity may be increased further at slight expense without making any change in the original equipment; that the various operations required to make the drill steel and to reforge and temper used steel are performed with the fewest possible movements and with the least amount of exertion on the part of the operator; and that the character of the work when executed conforms with the established standard for the existing conditions.

To secure these results the building should be of such size that the various machines and their appurtenances may be placed in the most advantageous position. It should be built of materials that are accessible and in conformity with the standard surface equipment of the mine. It should be lighted in such a manner that the piece being worked upon and the operating end of the machine employed are clearly visible to the operator, so that his vision of the parts is not obstructed by shadows. In addition to meet the requirements of a shop of the size and type herein described, certain features of equipment are recommended in Table I.

Equipment for Transporting Drill Steel.—In order to obtain maximum efficiency in a drill-steel plant it is essential that the transportation of the drill steel be accomplished expeditiously and with a minimum effort, for, regardless of how suitable the mechanical equipment may be, it is impossible to secure and maintain maximum production from the machines and furnaces if a suitable means of transportation conforming to the requirements of the plant is not provided.

To meet the requirements of the type of plant described in this paper it is recommended that the shop, Fig. 1, be equipped with a permanent track and turntable the gage of which corresponds to the standard gage of the mine or quarry tracks, provided such gage does not exceed 36 in. For transporting the drill steel to and from the shaft, or loading platform, a division car of the Copper Queen type, Fig. 2, will be found to meet the requirements satisfactorily. This car may be equipped with a body detachable from the truck to facilitate the work of transferring the drill steel to the mine skip,

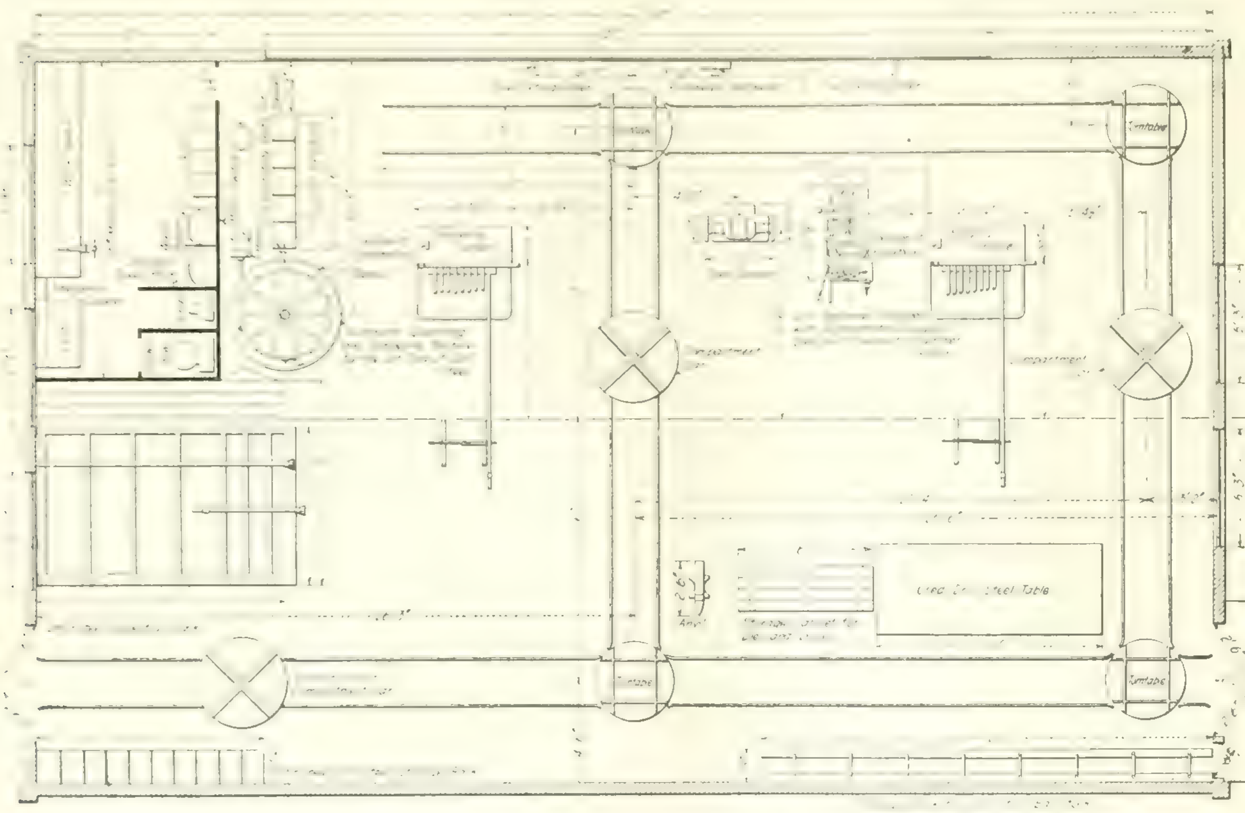

Fig. 1—Floor Plan of Ideal Shop for Sharpening Drill Steel.

TABLE I.—EQUIPMENT FOR DRILL-STEEL SHOP.

Transportation—
  100 ft. of 24-in. gage track (rail 35 lb. per yd.) comprising 36 wood ties [illegible] in.
  4 Mine-car turntables, 24-in. gage.
  1 Turn plate (if required).
  2 Compartment cars with revolving body (Copper Queen type).
  3 Division cars with detachable body (Copper Queen type).

Furnace—
  1 Forging furnace (oil or gas burner).
  1 Tempering furnace (oil or gas burner).
  2 Drill-steel supports for furnaces.
  2 Ventilators with hoods for furnaces.
  1 Oil storage tank.
  1-in. pipe with fittings for low-pressure air supply.
  ½-in. pipe with fittings for fuel supply.
  2 Pyrometers, equipped with base metal couples having indicator, voltmeter and cabinet.
  ¾-in. electrical-conduit piping (for pyrometers).
  2 Pyrene fire extinguishers.

Sharpener—
  1 Drill sharpener with full equipment of dies and dollies, including supplementary gaging dies and pneumatic-hammer punch.
  1¼-in. pipe with fittings for compressed-air supply.
  1 Storage cabinet for drill-sharpener appurtenances.
  2 Suspended drill-steel supports (for sharpener and grinder).
  1 Floor grinder (direct electric-driven) with two grinding wheels 18x2 in.
  1 Electric switchboard for motor.

Tempering—
  1 Rotary quenching and tempering machine (Homestake type), with 1-hp. motor.
  1 Electric switchboard for tempering-machine motor.
  1 Oil-quenching tank with cyanide receptacle.
  1 Ventilator with hood for cyanide receptacle.

Racks, Tables and Accessories
- 1 Inspection and bundling rack, with [illegible] gage cabinet.
- 1 Storage rack for drill steel in stock.
- 1 Storage rack for finished drill steel
- 1 Used steel table.

Sanitary Equipment
- 1 Sanitary drinking fountain.
- 4 Steel double-deck lockers.
- 2 Wash basins.
- 1 Sanitary towel rack.
- 1 Urinal.
- 1 Flush bowl.
- 1 Emergency cabinet.

General Equipment
- 1 Work bench equipped with 5-in. machinist's vise.
- 1 Desk with drawers and hinged top.
- 1 300-lb. anvil.
- 1 Set of hand chisels and sledges.
- 2 500-watt Mazda lamps with reflectors.
- [illegible] 100-watt Mazda lamps with reflectors.
- Water piping.
- Compressed-air piping [illegible] with [illegible]
- Waste piping.
- Oil piping.
- Electric wiring.
- Concrete floor.

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cage or wagon without removing the bars from the receptacle or it may be employed for the purpose intact, and in the case of a mine the whole may be lowered to the different levels where the distribution of the steel may be made in conformity with standard practice.

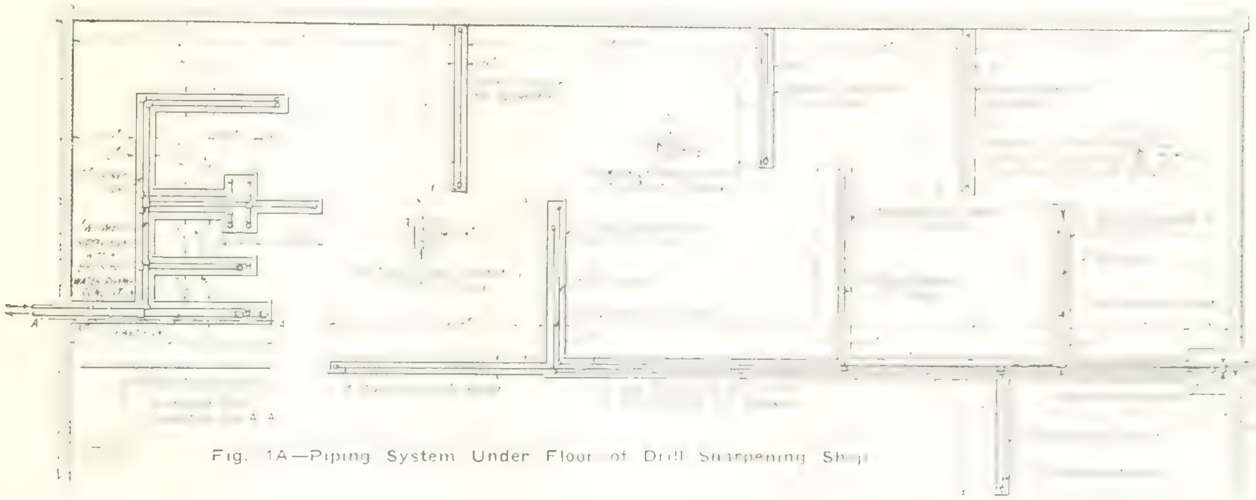


Fig. 1A—Piping System Under Floor of Drill Sharpening Shop

The compartment car, Fig. 3, consists of a truck having the wheel gage corresponding to the track standard, on which is mounted a revolvable compartment body supported by a ball bearing and equipped with a latch for locking the body with relation to the truck in any desired position. This car is employed for transporting the steel from the sorting table and the oil-quenching tank to the heating forges. In it the various lengths of steel are segregated, and by virtue of the revolvable body the insertion and removal of the drill steel is accomplished advantageously. Subsequent to the final heating of the bit the steel is transported mechanically by the tempering machine and deposited upon the inspection rack Fig. 4, whence it is loaded into the division car and transported from the shop.

The four turntables with which the track system is equipped provide means for the cars to be bypassed at any point except the dead end and, by having the main line extend through the building longitudinally, a convenient means is provided whereby the track system of the shop may be in intercommunication with the yard system and the other departments of the mine plant. At the outside of the building adjacent to the main entry a turn plate is provided, composed of boiler plate ⅜ in. thick, to facilitate the switching of the cars to and from a series of tracks from the yard system which may terminate at the outer edge of the plate.

Heating Furnaces for Forging and Tempering.—The heating of rock-drill steel preparatory to forging and tempering the bit and shank end is an engineering problem and it must be considered as such if maximum efficiency is to be obtained. The success of the furnaces employed depends upon the type and the method adopted for their operation. In order to perform their function in the most uniform and economical manner they must be constructed according to scientific principles in which the following considerations serve as a basis:

1. Size and shape of the drill steel to be treated.
2. Quantity of drill steel to be treated during a specified time.
3. Temperature required to insure proper [illegible] means for its regulation and maintenance.
4. Local conditions.
5. Most convenient and economical cycle of operations.

[illegible] cost, but as oil is of necessity adopted in a large majority of mining camps in this country, the employment of either as a heating agent will apply to the type of furnace described herein. For present-day requirements of the average mine or quarry, situated in many instances in remote and inaccessible places, where the carrying of a varied stock of refractory material is not only difficult but also expensive, simplicity of furnace design with special regard to repairs should be considered primarily. With this in view, the refractory material used in the construction of a furnace should be composed solely of standard-size firebrick, procurable in almost every local market, and it should be assembled in such a manner as to enable any blacksmith to repair or rebuild it with ease and dispatch.

The heating chamber of the furnace should preferably be of such size and shape [illegible] steel if heated by reflection or radiation rather than by direct impingement of the flame on the metal. This will prevent blistering and reduce the formation of excessive scale which is likely to result if the flame is caused to play directly on the metal. The heating chamber should be of such size as to absorb economically the heat of the products of combustion.

A certain amount of flexibility that may be taken advantage of by an untrained operator is desirable, inasmuch as the character of the flame required for heating to the best advantage, standard types of $\frac{7}{8}$-in. hexagon and $1\frac{1}{4}$-in. round hollow steel will vary with the size of the bit and the shape of the drill shank; and, in the case of the lugs or collars on the shank, will require only the heating of that portion to be upset, without affecting the extreme end of the bar, and thus obviate the necessity of cooling the tip before it is inserted in the dies of the drill sharpener. The flexibility may be secured by employing a burner of such construction that a perfectly round or fan-shaped flame is produced at will by the operator by merely adjusting a thumb-screw. Another desirable feature of such a furnace is to have at the end of the chamber from which the drill steel is withdrawn a maximum heat zone of constant and uniform temperature from which the temperature is lowered gradually but to an appreciable degree toward the end opposite where the steel is inserted. This will give the steel time to absorb the heat gradually, and will secure uniformity in the opening of the grain as the steel bars are handled in rotation.

It has been determined by experiment that a time period of 4 minutes is desirable for heating the larger sizes of bits formed on $1\frac{1}{4}$-in. round hollow drill steel and in order to insure an ouput of one steel every 30 seconds from the forging furnace, the mouth or opening for the insertion of the steel should be 2 ft. 6 in. long with a height of $3\frac{1}{2}$ in. Pyrometer readings should be taken from that part of the furnace directly adjacent the drill steel at the point of withdrawal.

If desirable, the low-pressure air supply for the furnace may be secured from the main high-pressure air supply of the mine or quarry, in which case a pressure-reducing valve should be used to secure a terminal pressure of approximately 15 lb below the lowest fluctuation of the main-line pressure. This reducing valve may be placed in the wall adjacent to the point at which air enters the building, from which a supplementary low-pressure air duct is provided for the two furnaces as shown in Fig. 1A.

To obtain the best results from any type of burner in point of economy and ease of operation it is of prime importance to have both the oil and the atomizing agent as constant and steady as possible. After passing through the pressure-reducing valve it is desirable to have the air for the furnace supply pass through a pipe mounted directly over and running lengthwise with the mouth of the furnace. In this pipe provision may be made by drilling a series of small holes directed downward—for the escape of a part of the air which will serve the double function of preventing the waste gases from flowing out in the face of the operator—and assisting in keeping cool that section of the drill-steel bar that projects from the furnace. After passing along the mouth of the furnace the air should preferably make two three-quarter circuits on the top of the brickwork, but inside of the cast-iron casing, for preheating it, preparatory to admission to the burner. Fig. 5 shows a furnace constructed along these lines.

The drill-steel support shown by Fig. 6 provides a simple, rugged and convenient means for supporting the drill steel during the heating operation. Constructed from flat bars of ½x2-in. low-carbon machinery steel or wrought iron, it may be made by any blacksmith with an ordinary forge-shop equipment.

The Drill Steel Sharpening Machine.—By far the most essential requisite of a drill-steel plant is the machine for forging the bit and shank ends of the drill steel. There are few apparently unimportant items of expense that are likely to assume more serious proportions than the wasting of time by men, caused by failure of the machine to turn out the finished product in a condition that meets the requirements of the plant. Correct sizing and shaping of rock-drill steel are just as essential to efficient mining as the efficiency of the drill itself and, therefore, a machine sharpener should be adopted that conforms with these requirements and in addition produces the bit and shank end in the best possible condition to be tempered.

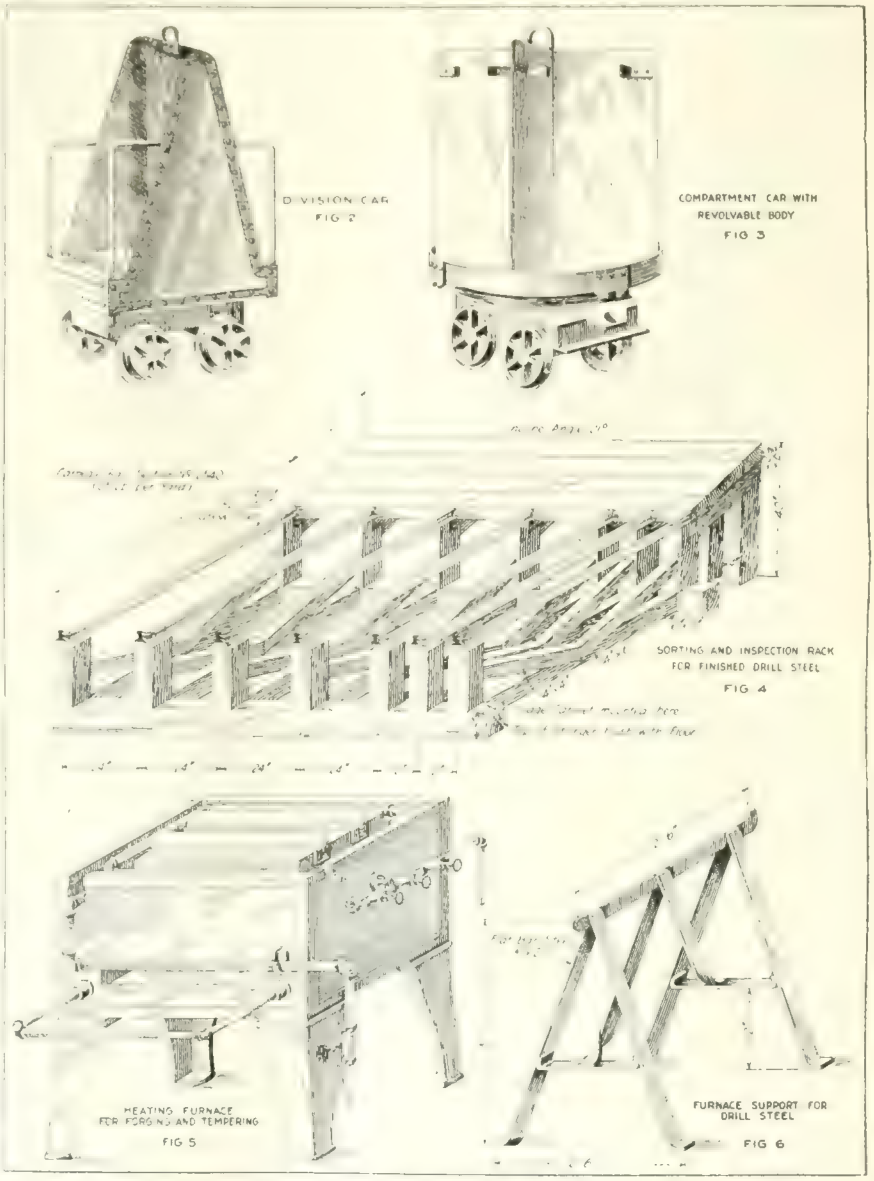
It is a well-known fact that the "standing-up" quality of a piece of steel when forged to a finished shape by hammering under light rapid percussive blows, is superior to that secured by any other known method. For this reason a drill sharpening machine answering this requirement is desirable. It should be equipped with means supplementary to the main forging dies for gaging the various sizes of bits mechanically, within close limits, and for punching out the axial hole of the steel at both the bit and shank ends. In construction it should be strong enough to withstand without undue wear or breakage the severe service to which it is subjected and all control levers should be interlocked in order to insure the various operations being performed in proper sequence and with a minimum of danger both with respect to the operator and the steel being worked upon.

For the storage of dies, dollies and other drill-sharpener appurtenances, the cabinet shown by Fig. 7 will answer the requirements satisfactorily. Placed at a convenient distance with respect to the drill sharpener and between the used-drill-steel table and the anvil, the heights of which correspond, it serves also as a support for the drill-steel bar stock when being cut to proper length preparatory to forging and also as a straightening bed for bent steel by virtue of the three bars of iron rail with which the top of the cabinet is equipped.

A floor grinder, preferably direct-motor-driven and equipped with two 18x3 in. corundum or carborundum wheels, should be placed at the left of the drill sharpener where it will be readily accessible to the operator. The function of the wheel adjacent to the sharpener is that of squaring off the ends and redressing drill shanks, while the wheel opposite, which should be preferably of somewhat finer grain, may be employed for refacing dies and dollies and other general grinding. The speed of the grinder when driven by a 5-h.p. motor should be 1,150 r.p.m. When grinding drill shanks the steel may be supported by a hook suspended from an overhead trolley having its track mounted in alignment with the grinder wheel and at right angles to the grinder shaft.

The heat treatment of rock-drill steel is a factor which determines success, as applied to the excavation of rock, to as great a degree as the heat treatment that is accorded the various parts that enter into the construction of the drill itself and, when the requirements of the work are once fixed, it is of the utmost importance that the temper of each piece be the same. This result may only be secured by reducing to a minimum the personal equation. While many expert steel workers are able to determine by experiment the required hardening heat and the cooling method for steel of various chemical compositions, the human potential is influenced by the physical condition of the man, and in order to carry the operation of tempering beyond the point of human influence, machinery must be employed as a substitute.

For the requirements of a drill-steel plant of the size and type described herein, the tempering machine for the bit end of the steel as developed by the Homestake Mining Co. is perhaps the most satisfactory. This machine, preferably motor driven as shown in the plan view, Fig. 1, is placed at a point adjacent both to the tempering furnace and to the



Figs. 2-6—Accessory Equipment for Ideal Shop for Sharpening Drill Steel.

main water supply, and is so positioned and equipped with guide hangers that the drill steel, when discharged, [illegible] the inspection rack where it is accessible for inspection. Back of the tempering machine and adjacent to the heating furnace, where it is accessible to the comaprtment car when placed near the dead end of the track, is the oil-quenching compartment tank shown in Fig. 8 with its supplementary receptacle for cyanide of potassium. This is employed only for tempering the shank end of the bar. Both tanks are preferably of steel construction and it is recommended that the inner surfaces be coated with an acid-resisting paint as insurance against oxidation.

Storage Racks and Tables.—The used-drill-steel table of the type shown in Fig. 9, on which the used drill steel is deposited from the division car, provides a means for facilitating preliminary inspection. If bent or plugged steel is found, the defects are corrected by using the straightening and cleaning facilities provided on the top of the drill-sharpener cabinet before the steel is loaded into the compartment car preparatory to heating for forging. In the case of broken steel it is cut to length, piled on the floor at some convenient point until a sufficient quantity has accumulated, when, as regards the necessary forging and tempering operations, it is treated as new steel.

For the storage of finished drill steel a rack, shown by Fig. 10, and placed adjacent to the inspection sorting rack, is recommended. This rack should have compartments preferably made of boiler plate, and should be equipped with a base plank of hard wood to protect the floor and to insure the bit ends of the finished steel against chipping. The various compartments serve to accommodate the different lengths and types of drill steel that may be employed. From its position, as shown by Fig. 1, the finished drill steel may, when required, be transported directly to the division car or to the inspection rack for bundling.

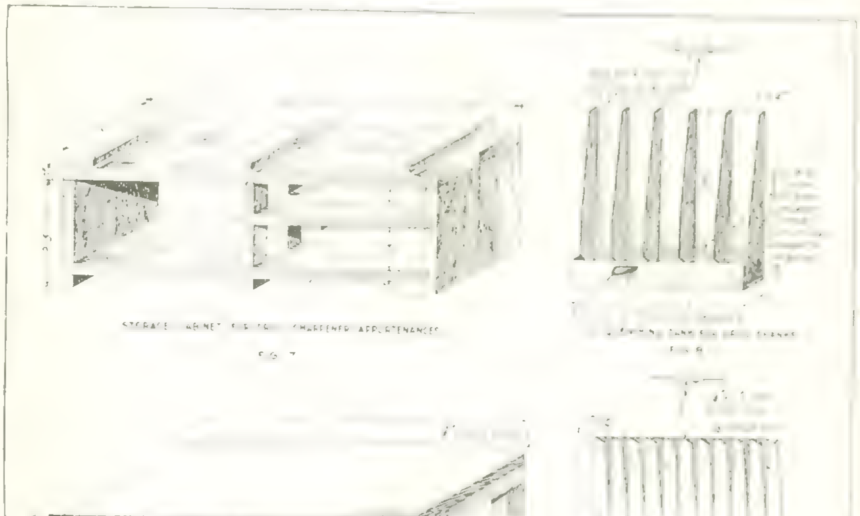
A convenient and inexpensive storage rack for drill-steel bar stock is shown by Fig. 11. This may be constructed by any experienced mechanic or blacksmith from standard materials usually sold by hardware stores in every mine and quarry district. Preferably the base timbers are embedded in the concrete floor while the top stringers may be fastened by any means convenient to the girders of the building. From its position opposite the supplementary doorway in the east end of the building (Fig. 1), where it is conveniently situated for receiving the material, the various sections and sizes of drill-steel bar stock may be readily removed and carried to the anvil and straightening bed for cutting to the desired length for forging.

Inspection Rack for Finished Drill Steel.—For inspecting the finished drill steel a rack, the details of which are shown by Fig. 4 will be found convenient, as it permits the inspector to walk between the [illegible] work of inspecting and sorting. After inspection the steel bars may be easily rolled to the edge near the track, from which they can be loaded directly into the division car, or transferred to the finished drill-steel rack as desired. As shown by the general plan, the inspector's gauge cabinet, Fig. 12, is mounted on the timbers of the [illegible] where it is conveniently accessible. In this cabinet, which is equipped with sliding doors, [illegible] are provided for storing the necessary gauges and measuring devices.

Sanitary Toilet Room Facilities.—The toilet room illustrated in the plan view is in a corner of the building where the space it occupies is not required for other equipment. It is adjacent to that part of [illegible] required for the tempering [illegible] of water piping necessary [illegible]

[illegible] placed [illegible] the outer wall of the building, to minimize the liability of freezing in cold weather. Furthermore, this arrangement permits the placing of the work bench and the foreman's desk, Fig. 13, where the light from outside may be used to the best advantage. Double-deck lockers, one for each work[illegible] a sanitary paper [illegible] placed in the main shop adjacent to the toilet room, complete the sanitary [illegible]

Compressed Air Supply in Shop.—[illegible] sarily used for operating the drill sharpener and, in the ab[illegible]


STORAGE CABINET FOR [illegible] SHARPENER APPURTENANCES
FIG. 7

[illegible] TANK FOR [illegible] SHANKS
FIG. 8

[illegible] STEEL TABLE
FIG. 9

STORAGE RACK FOR [illegible]
FIG. 10

[illegible] CABINET
FIG. 12

[illegible]

the hole in hollow drill steel and to assist in cleaning out [illegible]

[illegible] cle to be closed automatically. It preferable for the final inspection of the drill steel, water under pressure instead of [illegible] which case the nozzle of the gun is preferably equipped with a packing flange and a soft rubber gasket which, when compressed against the end of the steel shank provides a seal and prevents undue leakage. In Fig. 1A subfloor conduits for the compressed air piping are shown.

Heating, Lighting and Ventilating the Shop.—For heating the building in cold weather a four rod radiator composed of 2-in. wrought pipe, extending from the west entrance and along the west, north and east walls to the east entrance, will answer requirements satisfactorily except for extremely cold climates, in which additional coils may be required. Live or exhaust steam may be employed for the purpose but in either case the precaution of providing suitable drains in the system should be taken to insure against freezing.

The lighting and ventilating facilties of the plant are items that should receive due consideration. In Fig. 1 is shown the location and size of the windows recommended for a plant of the type herein described, on the assumption that the machines are placed on a line running east and west and the normal position of the operator faces in a northerly direction to avoid the direct rays of the sun falling upon the front side of the furnace and drill sharpener. A steel sash pivoted at the sides is recommended for the windows and may be operated by means of a rocker shaft procurable from the manufacturers of such apparatus. The windows at the ends of the building may, if desired, be composed of four rows of sash, while the sill of the window in the north side of the building should preferably be mounted at least 7 ft. above the floor and composed of eight panels, in a single row, operated by one gear from the rocker shaft. From such construction, a fair degree of natural light and ventilation is secured. For exhausting the gases from the heating furnaces, suspended hoods, adjustable vertically and equipped with telescope flues extending through the roof of the building, should be provided.

Artificial light sufficient to meet the requirements of the main shop may be secured from two 500-watt Mazda lamps with reflectors, supported from the roof on a center line through the building, one of which should be placed at a point slightly to the left of the drill sharpener, while the other should be slightly to the left of the tempering furnace. One 60-watt Mazda lamp suspended by an extension cord directly over the desk in the toilet room will be found ample for the purpose.

The floor of the shop should preferably be of concrete, poured after the wood base plates of the various fixtures, including ties for the track system, are placed in position. Conduits for all subfloor piping should be provided (see Fig. 1A) of such size and shape that there is ample clearance for the pipe and its fittings, with provisions for a covering with wood plank. The advantage of this construction is obvious as it provides a means for making the system readily accessible in case the pipe should become plugged or broken through accident. If desirable, a wood floor pad made of 2-in. planks may be embedded in the concrete at various points repeatedly covered by the operators. This provides for a certain amount of resiliency which will be found advantageous.

By adding 24 ft. to the east end of the building and the installation of an extra drill-sharpening machine, heating furnace, grinder, cabinet for drill sharpened appurtenances, and track with one turntable, the output of the plant may again be increased approximately 50 per cent by the addition of two operators. The ultimate capacity of the plant will then correspond to the requirements of all but a few of the largest users of rock drills in this country having a central drill-steel plant.

Procedure to Adopt for Making New Steel.—Remove the drill-steel bar from the bar-stock rack and place it on the top of the drill-sharpener cabinet with the end of the bar to be cut off supported by the anvil. Nick the bar at the desired point, using a chisel and sledge and break to length, leaving temporarily the pieces to be worked upon on the drill-steel table. When a sufficient quantity of pieces are available, place in the heating furnace, handling the steel in rotation by inserting a new piece when one is removed, after having attained the required degree of heat for forging. Form the shank in the drill sharpener, using the grinder and pneumatic punch, if necessary, after which place in compartment car, shank end down. When the forging operation is completed, turn the compartment car one-half way around, place the shank end of the bar in the tempering furnace, handling the steel in rotation as before and, when the shank has been heated to the required degree for tempering, remove from the furnace, dip the tip end in the cyanide of potassium and then plunge the heated end in the oil vat, allowing it to remain in the oil until cool. Now remove the steel from the oil vat and place it in the compartment car shank-end down. Run the car to its position adjacent to the forging furnace, remove the bar and insert the blank end in the furnace, handling it in rotation as before. Form the bit to the required gage diameter for the particular length of the piece being worked, after which place it in the compartment car at the left of the furnace. When the forging operation of the bit end is completed, turn the compartment car halfway around, place the steel in the tempering furnace, handling it in rotation as before and, when the required degree of heat is attained, quickly insert it in the bath of the tempering machine. After the steel has reached the inspection rack, inspect each piece carefully, place the pieces that pass inspection in the finished-drill-steel storage rack or in the division car and rework the defective pieces if any are found.

Procedure in Reworking Used Drill Steel.—After the used drill steel is transported by means of the division car from the shaft, or receiving platform outside of the building, it is deposited on the used-drill-steel table, where it is subjected to a preliminary inspection. If bent or plugged drill steels are found they are straightened and cleaned out by the use of the anvil in conjunction with the straightening bed on top of the sharpening- machine cabinet, after which they are storted and placed in the compartment car. If a shank is found broken to such an extent that reforging and tempering are warranted, the steel is discarded temporarily and placed in position convenient for reforging when a sufficient quantity has accumulated to warrant the operation, in which case the procedure will be the same as that required for shanking new drill steel.

In the case of shanks that merely require regrinding to put them into proper working condition the steels are placed in the compartment car (shank end down), which, after being loaded, is pushed to a point adjacent to the grinder, where such steels are removed and redressed, after which they are placed in the car (bit end down) and the whole is transported to a point adjacent to the forging furnace where the procedure for sharpening the bit is the same as that required for the bit end of new drill steel. After the final inspection they are again bundled, if such be the practice, loaded into the division car and transported to the shaft or loading platform, for distribution.

If desirable, a lessening of the distance covered by the operator, while removing the steels from the furnace, forging and grinding prior to depositing them in the compartment car, can be made. The grinder, drill sharpener and forging furnace may be grouped more closely together and the sharpener and furnace set at an angle of 70° with relation to the longitudinal line of the building by swinging the working end of the sharpener and forging furnace in a westerly direction from the position shown in Figs. 1 and 1A. The oil-quenching tank for drill shanks may also be set at an angle of 60° with relation to the tempering furnace by swinging the end of the tank nearest the north wall in an easterly direction.

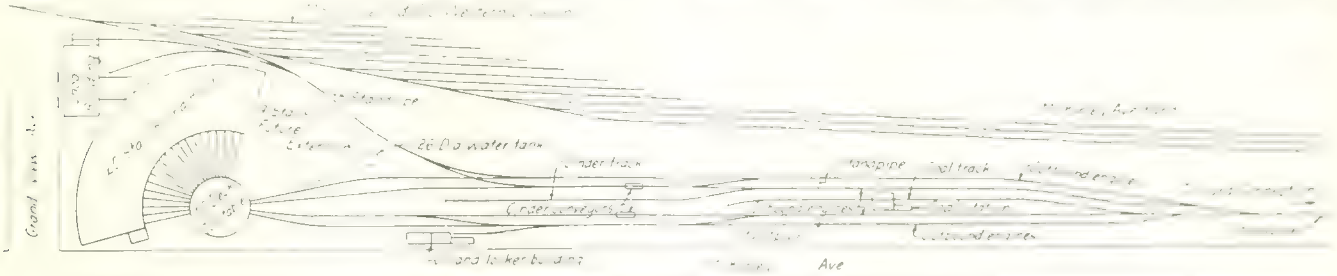
Method of Preventing Slides and Surface Water in Railway Cut.—Trouble from sliding banks and surface water in a 900 ft. long cut on the Boston & Maine Ry. was remedied by drainage. The method is described by Mr. B. F. Brown, Supervisor B. & M. R. R., in the March Maintenance of Way Bulletin. The cut was 20 ft. in height above the rail. The upper strata of the cut was of sand and gravel, while the lower strata was of blue clay. Natural springs developed in the bank on the westerly side and during the winter of 1911-1912 it was necessary to keep men there night and day at times to keep ice picked from track. In the spring of 1912 the westerly bank began to slide in, on account of the deep ditch and the track became in very bad condition. That summer a deep trench was dug 5 ft. below the ties and a "V" formed by nailing plank together. An 8-in. tile pipe was then laid the entire length of the cut and the trench filled with coal cinders from ash pit. The track was lifted 6 in. on cinders through the cut. No trouble has occurred at this point since the pipe was put in.

Meeting of Society for Promotion of Engineering Education.—The annual meeting of this society will be held June 25-28 at John Hopkins University, Baltimore, Md. Each half day session will be devoted to papers and discussions of some special topic.

A Modern Engine Terminal

The Toledo & Ohio Central Ry. has recently completed at Columbus, O., a 20-stall reinforced concrete roundhouse, together with the necessary yard and various facilities. From an extended description in the Railway Age, the following data are taken as being representative of modern practice in the building of these structures peculiar to railroad work.

The track layout, reproduced herewith, shows the respective locations of all the facilities. The lead to the terminal consists of four tracks, two inbound and two outbound, with the latter on the outside. These four tracks are independent all the way from the turnout to the table, it being the idea to provide a progressive movement in one direction on each track, with the engines receiving coal and water and dumping cinders while on the inbound movement and water only on the outbound movement. However, crossovers are provided between the inbound and outbound tracks of each pair so that engines may come in for coal and water or even to dump cinders and back out over the crossover onto the outbound track with a minimum of interference with the regular operation of the terminal. A track connecting with the north inbound and outbound tracks near the roundhouse affords a direct connection with the west end of the yard and serves also as a lead to the coal dock at the power plant.



Track Layout of New Engine Terminals at Columbus, O., of Toledo & Ohio Central Ry.

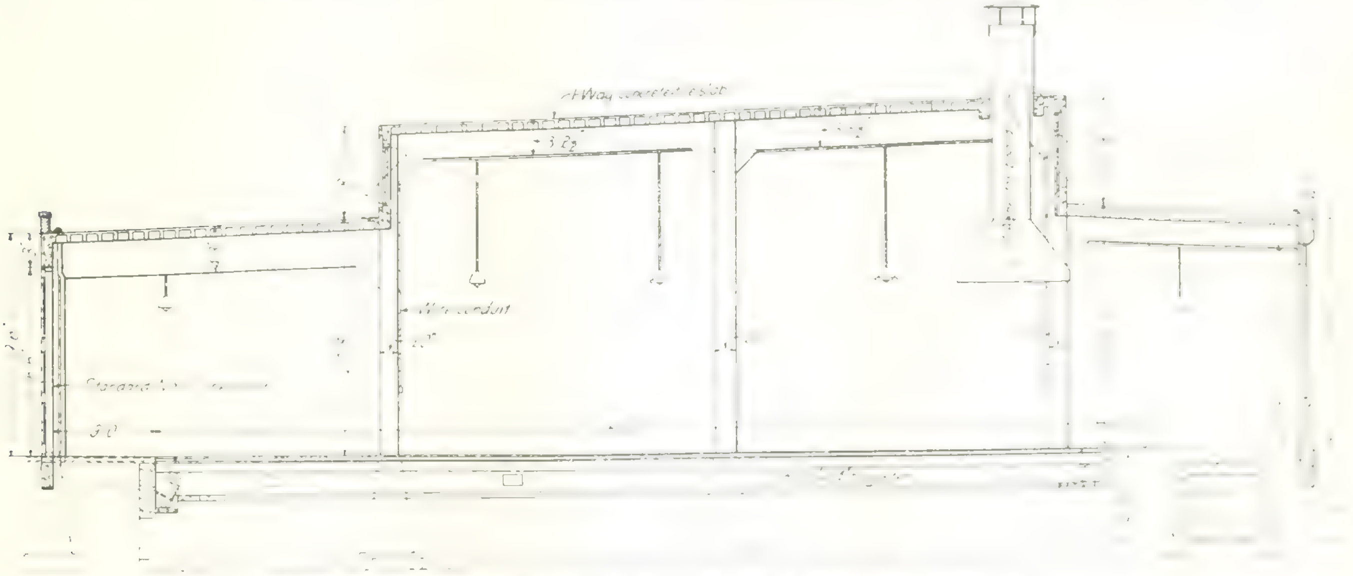
The coaling station is a Roberts & Schaefer plant of 500 tons capacity with a complete sand-drying plant in addition. The coal track for the station is located between the two inbound tracks and passes over a track hopper underneath the superstructure of the station. The cinder plant consists of two Robertson cinder conveyors, dumping into cars on a track between the two inbound tracks.

Water is delivered to the engines by four standpipes. The water is stored in a 70,000-gal. redwood tank on a creosoted trestle frame.

The roundhouse stalls are 110 ft. deep with door posts 14 ft. center to center, while the width of the stalls at the rear is 25 ft. 11 in. The turntable is designed for an equivalent of E-70 loading and supported on a conical roller center with an extra heavy electric tractor supplied with current from an overhead collector.

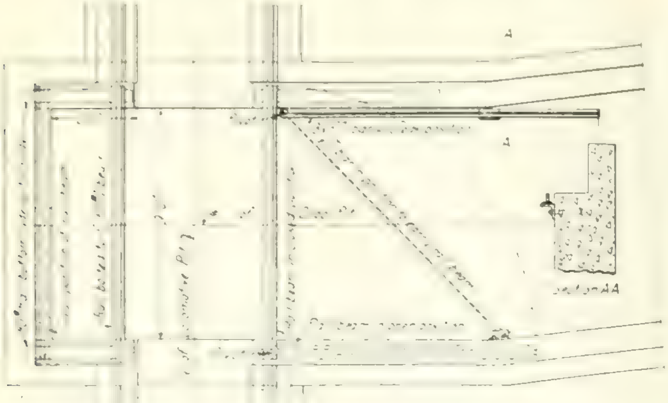
An interesting detail in connection with the [illegible] the roundhouse is the arrangement of the [illegible] the [illegible] three [illegible] panels separated by vertical construction joints. In the event of an engine pushing [illegible] of the [illegible] [illegible] little [illegible] portions. Fireproof construction was obtained by reinforced concrete with brick curtain walls. Attention is called to the one-way tile slab in the roof as it is expected that the air spaces in these tiles will effect a reduction in the condensation from the underside of the roof in cold weather. The roof is covered with Barrett composition. The roundhouse pits are of concrete, 3 ft. 11 in. wide, by 3 ft. to 4 ft. deep and slope toward the door end where catch basins are in[illegible]. These catch basins [illegible] roof, and in turn empty into the exterior drainage system consisting of a 12-in. sewer pipe leading to a settling basin in the yard. This was provided to remove sludge from the blowout water before allowing it to enter the sewers.

Stalls 17, 18 and 19 are intersected by a driver-removal pit, 7 ft. 6 in. wide by 6 ft. 10 in. deep, and stalls 18 and 19 by a truck wheel pit, 4 ft. wide by 4 ft. 9 in. deep. Each of these special pits is equipped with a 24-in. gage track for wheel trucks. An interesting detail has been worked out as shown in the drawing in connection with these special pits to facilitate the handling of the rail beams which carry the pit tracks over the special pits. The heavier of these girders weigh 690 lb. each, which is too great a load to be handled conveniently by hand. Accordingly T-bars have been provided to span across the pits as shown. The rail girder is pivoted on one side of the stall and the T-bar at [illegible] out of the way, the T-bar is swung out across the pit and its upper surface serves as a support for the free end of the [illegible] fitted into slots imbedded in the concrete. The upper portions of the pit walls are broadened out to afford adequate [illegible] tem from a fan and heating coils in the power house. The air is conducted from this heating plant through a system of conduits having a main duct leading along the rear of the



Longitudinal Section of a St[illegible] Engine Terminal, Colum[illegible] house with [illegible] between the stalls terminating in registers [illegible] in the engine pits, equipped with adjustable [illegible].

The power house and shop building is a structure 60 ft. by [illegible] ft. connected to the roundhouse proper by a wing [illegible] ft. by [illegible] ft. It has a steel frame with brick curtain walls and wooden roof construction following a standard design used by the contractor and for which he was able to supply the steel frame ready to erect. This building consists of a boiler room equipped with two [illegible] HP Union Iron Works water tube boilers with Jones automatic stokers fed by hand. The coal is received from cars by dumping from a low trestle so that the hand work is limited to transferring the coal from the pit under the trestle to the stoker hoppers. Adjacent to the boiler room is an engine room containing a two-stage air compressor with a capacity of 1,250 cu. ft. of free air per minute to 110 lb. pressure. This air is used to supply the ash conveyors, sand plants and two miles of 1½-in. train charging line in the yard.



Special Arrangement to Facilitate Handling of Rail Girders Over Drop Pits.

The heating plant consists of a Sturdevant fan blowing air through the coils, receiving exhaust steam from both the fan engine and the air compressor, although in cold weather it will be necessary also to use live steam direct from the boilers. The fan and ducts are designed of adequate capacity to supply air to the nine additional stalls contemplated in the design of the engine terminal. The remaining space in the shop and power plant building is used as a machine shop, air brake room and store room, with a toilet for the roundhouse employes.

Special attention was given to the lighting arrangement. Five lighting fixtures have been installed in the lines of columns between the stalls. As indicated on the longitudinal section of the house each fixture consists of a lamp socket attached to a section of pipe conduit and equipped with an enameled steel reflector. To light the passageways along the front and rear of the house every other lamp in the front row of lights is connected up in one circuit controlled by a master switch, while another switch controls the alternate lights in the outside row. The other four lamps in each row are controlled by local switches so that any stall may obtain additional light as neded. Supplementary to these lights there are outlets on two posts between each pair of stalls for extension cord lamps. There is also a socket at the rear of every second stall for an electric welding circuit. Illumination of the engine terminal outside of the roundhouse has been provided by installing flood lights on the top of the coaling station.

Bill Before Congress Provides $15,000,000 for River Improvements.—Completion of the Ohio, Mississippi and Missouri River projects within a period of 3 years is called for by a bill introduced June 5 in the House of Representatives. The bill provides for the following appropriations: Mississippi River, for 8 ft. channel, and 6 ft. channel, $4,000,000; Missouri River, 6 ft. channel, $3,000,000; Mississippi River, 6 ft. channel between mouth of Missouri River and St. Paul, $2,000,000. The bill also calls for an appropriation of $6,000,000 for lock and dam construction on the Ohio River.

Congress Votes $750,000,000 to Railroad Fund.—Congress has passed the bill authorizing an appropriation of $750,000,000 for the railroad administration's revolving fund.

Unit Price Contracts Vs. Percentage Contracts*

By W. L. DARLING

In construction one or more of three different methods are employed.

First, company force;

Second, unit price or an agreed sum with a provision for a percentage to be increased or decreased as the cost of the work decreases or increases, compared with the agreed cost;

Third, a percentage based on the actual cost of the work.

In the present state of the art, I think it can be safely assumed that the first method should be used only when the work is too small to contract, or when the local or emergency conditions are such that it is not practical to contract, or when the owner has experts in a certain specialized line that are superior to those of the contractors.

The main question, therefore, is: Shall the second or third methods be used, and if the third, will it affect the art and consequently the public?

To discuss it, it is necessary to examine the effort of the contractor himself. The great incentive is to make money, and it is this incentive that has created his value to the owner and to the public. The overcoming of obstacles, financial as well as physical, has produced energy and versatility that could have been acquired in no other way, and to my mind, energy is his greatest asset. What use is it if he has all the intellect and physical qualities in existence if he has not the energy to use them?

He must have a knowledge of men and plant; where labor can be readily obtained and the plants available; he must know about his supplies, where they can be obtained and how best transported; he must know the market conditions and have an intimate knowledge of the work to be done.

If the work is done on unit price basis the owner gets the results of the judgment and the experience of many men and many firms; one will see better where supplies are obtainable; another may have a better plant for the job; another may have a better method of doing the work, and it is the pitting of all these men, one against the other, that the owner gets the advanage of.

By the percentage method a man or firm is selected for managing the work; hence the owner gets the benefit of one man's knowledge and the wrong man may have been selected. I have known men to make a bid on a piece of work by merely sizing it up, and knowing where the necessary outfits were and the men to whom it could be sublet. If he has made a bad guess he simply has to find some way or means to back up his judgment. I believe some men become so familiar with work that their guess is as good if not better than some men's figuring. At any rate the difficult tasks that they set for themselves brings out all the surplus energy that is in them and this is what the owner gets the benefit of and what he will not get should competitive methods be eliminated.

The contractor working on a unit price basis has not only a reputation but also his very livelihood at stake. We have often seen men take work at unit prices so low that a heavy loss seemed inevitable, but by using new methods, new tools and exerting surplus energy he has been able to turn an almost certain loss into a profit for himself, and a much greater profit for the public, as these new methods can be used on further work and by other men.

Contractors, I believe, can materially improve the art of drawing closer lines between their business and the owners. Unit prices and specifications should be more definite. The question of custom between contractor and owner should be eliminated. The contractor should have better data on which to base his bid. There has been a growing custom not to pay as much attention to the contract as to customery settlements. I believe that much better results would be obtained if the contractors would insist on the contract and specifications being followed, and if conditions should arise when the intent of the contract would be materially affected by having a definite understanding as to price and conditions before going ahead.

Under past conditions work has been suddenly authorized with no time given either the engineer or the contractor to determine costs or make intelligent bids. A much smaller margin between the estimate and the actual cost of work would result if these conditions could be known. The risk of the contractor would be much smaller, and the owner would have more definite knowledge of what his work would cost.

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*From an address delivered March 27 at an organization meeting of the Northwest Association of General Contractors, St. Paul, Minn.

An agreed price, varying with the percentage has many good points when the work is simple and conditions are such as to permit of it, but it could not be used very well on railroad work, for instance, unless the conditions were properly determined beforehand, and right here is where the owner or contractor can greatly improve present methods, by determining unforeseen conditions.

By the percentage method, the contractor has few financial troubles to overcome, no particular inducements except pride to introduce new methods or tools, no sleepless nights to figure out some new scheme for the next day, no surplus energy to exert in himself or employes. The employe, knowing that his superior is not in financial troubles, does not exert himself unnecessarily. The contractor does not, perhaps, try new methods or new tools as he may think he has no right to risk a failure. On the other hand, the unit price men must take the risk, and bend all their energy to make it successful.

My point is this: That these necessities of the unit price men have produced a personal result that could not otherwise have been acquired, and that as soon as the incentive is eliminated, progress will slow down, if it does not actually retrograde.

There is no question but what there are men doing percentage work that are just as competent and perhaps just as energetic as the unit price men, but I claim that it is because of the state of the art and its personnel, and due to previous efforts of the unit price men.

The main objections to the unit price methods are that in instances contractors make too much money, and that the percentage method will eliminate that danger.

Frequently a large profit is due to the fact that a contract was taken on a high market and the work done as the market fell. If the reverse condition obtained, there would have been a loss and no comment made.

It has seemed to me the best way to determine the amount of money made by contractors is to consider the work done here in the Northwest for the last 40 years, and then to determine the wealth of the various men who have been engaged in that business during that time, and who have not lost their money elsewhere. While it is true, perhaps, that in individual cases, owners have to pay larger sums than by a percentage method, I do not think it is generally true.

It seems to me that the great results of the unit price method is the fact that during the last 40 years under normal conditions, unit prices have decreased in the face of rising values of labor and material and have produced a class of men who when the emergency came, were able to accomplish things that did not seem possible. If you give up the unit price or competitive methods, it is going to result in one of two things: you are going to have a lot of superintendents or else you are going to have only a few great big contractors. In pioneer work sometimes a lot of money has been made. I have seen that in offering work and asking for proposals a number would look it over and make their bids, but some fellow would know the conditions better than the other and know how to save a lot of money and time by knowledge of those facts. However, he would go in and make a good big bid and the owner would accept it and the consequence be that he would make a lot of money.

There is, of course, the social side to consider. Will labor as a rule be better compensated or its welfare enhanced by either method? Personally, I do not think so, as welfare is a matter for legislation and compensation must be determined either by the market or by legislation.

There is a growing disposition all over the country to eliminate competition, but it seems to me that the better results will be obtained only where competition produces waste but not where it is a creator of new methods, inventions and energy.

Civil Service Examinations for Valuation Engineers.—The U. S. Civil Service Commission, Washington, D. C., has announced that examinations will be held for valuation engineer, at $3,600-$4,800, and assistant valuation engineer at $2,500-$3,600, for the technical staff, income-tax unit, Bureau of Internal Revenue, Treasury Department.

Government Public Works Activities As Aid to Resumption of Business

The N[illegible] [illegible] taken by the Congress of the United States in the restoration of general business activity the provision that the National Government shall concentrate into the immediate future its program of the [illegible] of public [illegible] be extended over the next several years, in order to effect a quick general resumption of business, which would follow the stimulus given by large Government activities. The following statement in the matter appears in a recent news letter of the Federation:

Since the signing of the armistice there has been a marked halt in production and general indecision in business. The unsound conditions usually preceding a business depression do not exist. It is the belief of many leading business men that uncertainty as to the stability of present costs of labor and material is the chief cause of business inactivity.

Investigation by Government experts and competent private agencies indicate that when business does resume it must be on the basis of present prices. In fact, the operation of the law of supply and demand, necessarily adjourned during the war, is slowly resuming, affecting in itself a stabilization of prices on the present level. This movement is, however, so slow that, unless accelerated, the country cannot hope for an early restoration of complete business confidence. We have the alternative of groping our way slowly to normal conditions, with an attendant extended dissipation of resources, unemployment and social unrest, or by concerted action through the agencies of the Government, of resuming business immediately at present cost levels, leaving future values to be determined wholly by supply and demand.

During the last six months the buyers of the country have made an unexampled attack upon prices by their refusal to purchase, and yet prices have not declined in any significant amount; and in the construction industry, which was largely curtailed during the war, many prices have advanced.

After a careful canvass of opinion, the directors of the Federation—potentially representing one-third of the industries of the United States, including producers, distributors, contractors, architects, engineers and all other branches of the industry, which normally employs more labor than any other industry in America—believe that no concerted movement of private interests can quickly and independently re-establish business confidence, and that the business of the country will be fully resumed only after a long period of loss and disquiet, unless the National Government takes action to correct the condition.

This matter has been discussed with some of the most conservative and careful business men of the county, and without exception they believe that a rapid return to normal business activity can be realized only through an example set by the Government by its becoming the first large purchaser of commodities at current prices.

In discussing this matter a few days ago one of the foremost men in the American [illegible] or group of men can, independently of Government support, effect an early restoration of business confidence; the Government itself must become the first large purchaser on the new price level. It would be the part of wisdom for the Congress to appropriate Ten Billion Dollars, if necessary, in order to terminate the present lassitude of American business. As a nation we would be financially better off in the end for having made the expenditure."

The Federation proposes, as one of the most important steps to be taken by the Congress of the United States in the restoration of general business activity, the provision that the National Government shall concentrate into the immediate future its program of public works, which would normally be extended over the next several years. The saving to the country, resulting from a general resumption of business following the stimulus given by large Government activities, would many times offset the saving effected by the several Government departments through their present policies of retrenchment or very limited purchase.

A corollary to this proposition is, of course, the immediate removal of all increases in freight rates on construction materials in excess of the increases which have been applied to other commodities in order that private construction may be in the best position to follow the example proposed to be set by the Government.

Some attention has already been given to the question whether a national policy should not be adopted to provide against future contingencies of business stagnation, by which less public work would be done in times of industrial activity and more during periods of unemployment. It is said that the normal amount of public money spent annually in the United States on public works is in the neighborhood of a Thousand Millions Dollars. It has been suggested that such a policy would provide a balance-wheel to American business, which, working in conjunction with the Federal Reserve Banking System, would in the future prevent great fluctuation in the amount of business transacted.

There will probably never be in the history of the United States a time when public works will be more important as a means of tiding the nation over a period of industrial depression than the present. We have had numerous expressions of opinion by business men that an example set by the Government, as suggested above, would be followed immediately by private business interests in general.

As a nation we can take our choice between quickly resuming business as usual, or continuing our present attitude of hesitation and indecision.

Handling Mexican Track Laborers

For several years the Santa Fe System has been using Mexicans as track laborers on its sections in the vicinity of Chicago. Some interesting notes on the best methods of handling this class of labor in track work are given by Mr. David Harris, Section Foreman, Joliet, Ill., in the Maintenance of Way Bulletin, from which we quote as follows:

These men are as a rule not very bright appearing, being slow to learn our ways, while the work being all new to them makes it necessary for the foreman to work very closely with them to get in best results.

Do not be afraid to take hold of the pick or shovel and show the man how to do the work, as in this way you will get quicker and better results. This rule of showing a man how, rather than telling him, being a good one to use in handling all classes of men and especially the Mexicans.

As a rule I have found the Mexican laborer inclined to be stubborn, difficult to drive but more responsive to nice, smooth handling, and I have found the latter method got the best results.

Aim to lay out a fair day's work for the crew, and when they do that and do it well, let them rest until the time comes to go to the camp. Never promise them anything unless you can keep your promise—failure to keep your word with them will mean that they will lose confidence in you, with consequent loss of efficiency in their work, but on the other hand do not always depend on them to keep their word with you for they do not always do that.

It is found that when some of these men are in the country a few years and learn a little English they will think they know more than the foreman or most anyone else, and will always be stirring up trouble of some kind. Get rid of such men quickly, as they make trouble makers the world over, and are detrimental to a gang or any body of men.

Never keep a man in your gang who is inclined to be idle and lay around camp, because such a man will soon have most of the gang staying in camp with him. Never allow them to bring liquor into camp, as intoxicants have spoiled more Mexican gangs than any other one thing. Get rid of the boozer with scant ceremony before he spoils your entire gang by having them loaf around camp, and even if by dismissing him you lose a few others, the balance of the gang will be the better for the weeding out.

Because of inexperience in American ways of business and ignorance of our language, the men often and in fact always have difficulties in getting their food supplies or clothing at the stores and the foreman should assist them in the various transactions necessary to their commissary, being careful always to know that they are treated fairly and not exploited by any unscrupulous person.

Show them that you are their friend and as long as you do that they in turn will do the right thing by you.

In conclusion, let me say that as a general proposition, fair treatment of Mexican labor will bring results, and I hope that the suggestions made in this article may be of assistance to foremen who are not familiar with this particular class of men.

New Classification for Rock Excavation

A new rock classification for excavation work has been proposed by Warren D. Smith, Professor of Geology at the University of Oregon. His classification, which is outlined as follows in Economic Geology, provides for four main groups:

The classification of rocks given in geology handbooks is too technical and too clumsy, as now arranged, for the use of the field engineer, and we find in the literature nothing very adequate which the engineer can use. In some cases he has fallen back on a classification something like this, which all geologists will recognize as being a very loose and unsatisfactory classification. For instance, I found the following classification in use by the engineers of a railroad company in Oregon: (1) Solid rock; (2) sandstone; (3) cement; (4) shale; (5) earth.

Now, all geologists know that there are many different kinds of solid rocks and many different kinds of sandstones, and so on. No regard is paid in this classification to the differences in cementing materials in the sandstones; there is nothing in here about structure, or texture, which determine the ease or difficulty in excavating the material. No attention is paid to whether the material is weathered or to the degree of alteration. For instance, the word cement may include many different kinds of cementing substances, silica, calcium carbonate or iron oxide, and it makes a great difference which one of these is the binding substance.

A good classification will probably have to include terms generally used by geologists, but these must be so grouped that we get in any one group materials which can be excavated with about the same degree of ease or difficulty, as the case may be. In the following proposed classification very heterogeneous substances are grouped together, but, taking into consideration texture, structure and composition, we think there are included those materials which, from our experience, we judge ought to be classed together for similar rating in regard to excavation.

We realize that this classification is open to criticism, but criticism is what is invited, for an excellent way to develop a good classification is to propose one, have it criticised, and then make a new one, or, if necessary, several new ones.

In the case of a small job, involving little financial outlay, where not very much can be either made or lost by the contractor, the old, loose classification as now used might be retained; but with a big piece of work, where thousands of cubic yards of rock have to be moved, it will pay both the company and the contractor to have a geologist. If the company retains no geologist on its staff then let it secure the temporary services of one, and have him classify the material to be excavated. In this particular case I know that several hundred dollars could have been saved.

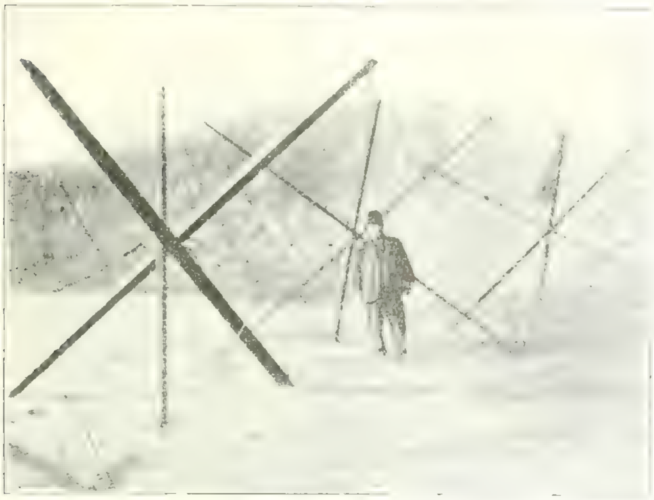
For use in connection with this classification we think that Pirsson's "Rocks and Rock Minerals," with the tables there included for rock determination, should be used. There is no escaping the fact that the engineer must know the common rocks and minerals. If he does not know them now, he must either take a course where he can learn these, or a geologist must be retained.

The following classification has four main groups, and is as follows:

Name.	
All granite rocks, granites, diorites, etc.	GROUP I. Solid and unweathered rocks
Sandstone (siliceous cement)	
Quartzites and quartz masses	
Traps, basalts, porphyries and volcanic glasses	
Conglomerates and agglomerates	
Gneisses, breccias	
All rocks of Group I, badly weathered	GROUP II. Intermediate rocks.
Sandstone (lime or iron cement)	
Limestones and marbles	
Serpentines, schists, slates and argillites	
Hardpan (cemented clay)	
Shales	GROUP III Soft rocks.
Rubble limestone	
Loose sandstone	
Coquina	
Marls	
Travertine	
Tuff	
Glacial till	
Silt	GROUP IV. Unconsolidated (earth).
Mud	
Sand	
Gravel	
Volcanic ash (loose)	

River Bank Protection of Skeleton Steel

Mr. J. W. Kellner of Silver Lake, Kan., has recently been granted patents for a new form of bank protection, which has been in successful use along the Kansas River in the vicinity of Topeka. As described in the Railway Age, from which the accompanying illustrations are reproduced, the protection consists of one or more units, preferably at least four, each unit consisting of three structural steel angles, 16 ft. long, properly fastened together in the center in the form of a jack stone, such as children use in playing jacks. The extreme ends of these three angles are fastened one to another with ½-in. wire cable. Various sizes of angles have been used. The four or more units are fastened one to another by wire cable, attached to the center of each unit, and this cable is fastened to a dead man some distance from the bank. The material is shipped in a knocked-down condition to the point of use. There each unit is assembled on the bank, the several units are properly tied together with one end anchored to the shore, and the whole jetty is rolled into place in the stream.



One of Steel Jetties Just After Installation.

Deposit of Sediment Resulting From Presence of Two Jetties.

At first sight it appears that there is little in this affair to protect the bank, but its apparent efficiency would seem to be due to the fact that the jetty decreases the velocity of the water passing through it sufficiently to deposit some of the sand being carried down stream by the swift current, and once a deposit is started it continues rapidly. Of course, brush catches in the prongs of the affair, but the jetty is not dependent upon this brush for results. In fact the builders claim better results where no brush interferes. Should brush lodge, and overturn the jetty, it is in the same position as before and unharmed.

The advantages of this jetty lie largely in its relatively cheap installation cost and to the short time required to place it, as compared with other means of bank protection. Experience with this construction indicates that the results are satisfactory. Then, too, the effect of this jetty in pushing the river away from the point of cutting is only moderate, so that the current is not turned sharply away only to have it do [illegible] damage at [illegible] point further [illegible] stream.

The pictures show the form of construction and indicate possible results. One illustration shows a jetty just after installation. The other picture shows clearly that a bar or deposit is forming below the point where two jetties had been placed. The river had given more or less trouble here, and considerable money had been spent in a small way without much success until this jetty was placed in the fall of 1918. The picture was taken just after the heavy rains, and high water of March, 1919. In all of 37 places where jetties of this kind have been installed the river has stopped cutting.

If the protection is required for some distance along the river, it is necessary to place the jetties at intervals of from [illegible] to 300 ft.

Reclaiming Frogs and Switch Points by Oxy-Acetylene Welding Process

[illegible] welding outfits [illegible] Chicago & Northwestern Ry. for the past three years for reclaiming track appliances in yards. The work accomplished with these outfits is described by Mr. A. W. Talbert, Roadmaster C. & N. W. Ry., in the Maintenance of Way Bulletin, [illegible] the matter following [illegible]:

At the time of the installation of the outfits the frogs were badly worn and had reached an extreme stage of wear. The shortage of material had brought this about and some of these frogs were worn up to the danger point, where flanges were running on the castings.

There are five outfits on the Madison Division. During the month of January, 1919, 53 frogs were repaired and a saving was made [illegible] per frog. On one instance in a freight yard a frog was close to the danger point. On account of the scarcity of material, this particular frog was removed from the track, but as it was the only emergency one on hand it was necessary to repair and build up this frog. It was found worn so that the flanges were running on the castings. One wing was broken clear across the ball and turned through the web and flange. The other wing was split for a distance of 18 in. In [illegible] for a distance of 8 in. also was built up. After the frog was completed it was put back into traffic. At the end of 32 days it was giving very good service and showing hardly any wear. It is polished up so now that if a man did not know the frog had been welded, and looked close, he would not know the difference between a new frog and the repaired one. A new rigid frog put into the same track under ordinary conditions and same traffic will last 90 days. About 100,000 tons pass over this frog daily.

During the same month 6 switch points were reclaimed at [illegible]

Cross arms for Odenkirk switch boards also are repaired at a cost of 1/6 of the first cost of the cross arms. Switch stands were also reclaimed at a small cost.

There are frogs in the track that were welded as high as three different times and at each time welded give the same service as a new frog.

During the summer of 1918 some battered and flowed rail ends in double track territory under heavy freight traffic were built up. Mr. Talbert finds that the welding is holding and the joints are worn somewhat at this time and hardly visible. Two men welding on an average of 6 joints per day in 8 hours' work. The joints were worn from ⅛ in. to ¼ in. and [illegible]

Mr. Talbert states that in his few years' experience with the oxy-acetylene process he finds during the winter months it is not economical to weld frogs under very heavy freight traffic as the frogs get bent. He recommends that frogs be removed from the track where such conditions exist. During the winter months it is not economical to weld outside on account of not being able to draw out the acetylene gas from the drum unless the drum is warm and up to about 70°. Otherwise there is a great amount of gas left in the tank and returned.

Views of Construction Industry on Present and Future Business Conditions

An analysis of the answers to a questionnaire sent by the National Federation of Construction Industries to 1,100 of the leading construction industries and related interests in the United States develops the fact that during the past few weeks general business conditions have greatly improved and that the prospects for the future are bright. A preponderance of opinion supports the view that the present price level is here to stay for an indefinite period of time and many believe that prices will go still higher.

The questions asked by the Federation were:

1. What is the condition of your business (bad, poor, fair, good or excellent)?

2. How do you classify your prospects for business during the remainder of the current year (bad, poor, fair, good, excellent)?

3. Do you believe that business when it resumes will be on the present price level?

4. What are your reasons for this belief?

5. Do you believe that unassisted by large Government purchases, the present price level will be adopted by a normal resumption of business, within the next year?

6. Within two years?

7. If you do not, are you in favor of large Government purchases to establish confidence in the present price level?

8. How much of an appropriation by the Federal Government for such purposes do you feel would be warranted, if necessary, within the next twelve months?

9. What recommendations would you make to get business quickly established on a peace basis?

10. What other remarks have you to make upon the situation?

In the analysis to the answers to these questions they are grouped as coming from the North Atlantic States, South Atlantic States, North Central and North Western States, South Central and South Western States.

The answers to question No. 1, as to the present condition of business are as follows:

	Bad Per cent	Poor Per cent	Fair Per cent	Good Per cent	Excellent Per cent
North Atlantic States	[illegible]	10	8	[illegible]	54
South Atlantic States	4	8	48	21	16
North Central and North Western States	2	17	18	18	14
South Central and South Western States		12	30	41	7

The answers to question No. 2, as to the prospects of business for the remainder of the year are as follows:

	Bad Per cent	Poor Per cent	Fair Per cent	Good Per cent	Excellent Per cent
North Atlantic States	11	[illegible]	[illegible]	[illegible]	7
South Atlantic States		8	22	62	8
North Central and North Western States		4	26	33	12
South Central and South Western States			8	[illegible]	18

The answers to question No. 3, as to whether the present price level will continue are as follows:

	Yes, slightly [illegible] Per cent	Yes, slightly [illegible] Per cent	Yes Per cent	No Per cent
North Atlantic States	1[illegible]	[illegible]	[illegible]	7
South Atlantic States	[illegible]	1[illegible]	50	[illegible]
North Central and North Western States	1[illegible]	[illegible]	[illegible]	
South Central and South Western States	17	18	[illegible]	

The answers to question No. 5, as to whether normal business will support the present price level during this year, are as follows:

	Yes. Per cent	No. Per cent	Uncertain. Per cent
North Atlantic States	[illegible]	[illegible]	[illegible]
South Atlantic States	[illegible]	[illegible]	[illegible]
North Central and North Western States	[illegible]	17	[illegible]
South Central and South Western States	[illegible]	[illegible]	[illegible]

The answers to question No. 6, as to whether normal business will support the present price level during the next two years are as follows:

	Yes Per cent.	No. Per cent.	Uncertain. Per cent.
North Atlantic States	[illegible]	19	25
South Atlantic States	[illegible]	25	30
North Central and North Western States	[illegible]	[illegible]	65
South Central and South Western States	39	21	40

The answers to question No. 7, "Do you favor large Government purchases to establish confidence in present prices," are as follows:

	Yes Per cent	No Per cent	Uncertain Per cent
North Atlantic States	19	62	19
South Atlantic States	12	80	8
North Central and North Western States	15	75	10
South Central and South Western States	21	[illegible]	19

Question No. 4 requests reasons for the answer given in question No. 3, as to whether the present price level will continue. The analysis of the reasons given by those who believe that the present price level will continue, are as follows:

	Per cent.
Because of supply and demand	1.5
Because of [illegible] of material	6.6
Because of [illegible] of material	6.7
Because of high cost of food and other living expenses	9.0
Because of high wages and attitude of labor	58.1
Because of general and miscellaneous reasons	18.1

The latter reasons include shortage of material and labor which will develop when normal domestic and probably foreign requirements are realized. The opinion is also expressed that people will soon become accustomed to spending money on the new price level and will thereafter spend as freely as they have in the past.

An analysis of the reasons given by those who believe that the present price level will not continue but will go lower, is as follows:

	Per cent.
Because prices already have decreased	2.7
Because lower living costs will reduce wages	5.4
Because of supply and demand	8.2
Because lower prices are necessary to stimulate business	27.0
Because we are changing from war to peace conditions	29.7
Because of general and miscellaneous reasons including several of the above reasons	27.0

The answers to question No. 9, "What recommendations would you make to get business quickly established on a peace basis," and to question No. 10, "What other recommendations have you to make upon the situation," inolved so many considerations as to make it practically impossible to segregate the answers into groups. Among the more prominent recommendations and suggestions are:

a. The repeal or modification of the Sherman Anti-Trust Law.

b. Favorable Merchant Marine laws.

c. Extending the Webb-Pomerene Act.

d. Government loans for housing construction.

e. National, state and municipal governments should proceed with all public works authorized.

f. Educational campaign to convince the public present prices are permanent.

g. Send business men to Congress.

h. Sign the Peace Treaty.

i. Government should return all private property to owners.

j. Discontinuance of war-time administration of private business.

k. In a few cases the answer is: "Normal business has already resumed."

Loosening Hard Soil with Dynamite

In digging a trench for a 4-mile water supply line soil was encountered that was so hard as to require picking. After about 1 mile of ditch had been dug it was decided to loosen the ground by blasting. This was done as follows:

The tools required were two 10-lb. sledge hammers and a steel drive point 1½ in. in diameter. The sledges were used to drive the steel bar into the ground making the holes 2 ft. deep in which the charges of dynamite were loaded. The holes were spaced 4 ft. apart, each hole being loaded with ¼ lb. of 40 per cent dynamite well tamped in. As no blasting machine was available, a blasting cap and length of fuse was inserted in each charge. The charge being small, a man could go along the line of charges lighting the fuses without risking any danger from the blasts going off 40 or 50 ft. behind him.

The experiment was an entire success. The small blasts loosened the hard ground very nicely. It was possible to shovel out most of the dirt without any picking whatever. Because of the time of labor saved by the blasting, the cost of the work was greatly reduced and the time of completion of the job decidedly shortened.

Salary Schedule and Classification Suggested by Draftsmen's Union

In a brief submitted at a hearing held May 12 and 1[illegible] by the Board of Railroad Wages and Working Conditions of the U. S. Railroad Administration representatives of the International Federation of Draftsmen's Unions presented a classification for draftsmen, together with minimum salary scale. The salary schedule recommended by the union was as follows:

	M[illegible] per [illegible]
Chief draftsman	[illegible]
Leading draftsman or squad man	[illegible]
Draftsman, Class A	[illegible]
Draftsman, Class B	[illegible]
Draftsman, Class C	[illegible]
Tracer, Class A	[illegible]
Tracer, Class B	[illegible]
Assistant engineer or engineer inspector	[illegible]
Assistant inspector, Class A	[illegible]
Assistant inspector, Class B	[illegible]
Instrumentman	[illegible]
Rodman, Class A	[illegible]
Rodman, Class B	[illegible]
Tapeman, Class A	[illegible]
Tapeman, Class B	[illegible]

Regular hours to be 7½ hours on 5 days of the week and [illegible] on Saturday, making 41½ hours per week.

No overtime except where absolutely necessary, and at the option of the employe, and time and one-half for all overtime ordered or made necessary.

All traveling and other expenses incurred for railroad business and also expenses attached to [illegible] allowed.

Civil service rules to apply regarding vacation, holidays and sick leave.

No salaries now in existence to be reduced.

The following classification for the above positions was given in the brief:

Chief Draftsman—In direct charge of office performing technical engineering or architectural work [illegible] squad men report directly to the chief draftsman.

Leading Draftsman or Squad Man—In direct charge of a group of men under the jurisdiction of the chief draftsman capable of designing and directing design.

Draftsman, Class A—With experience, capable of designing complex and difficult work.

Draftsman, Class B—With experience, capable of designing simple work and capable of detailing difficult work.

Draftsman, Class C—With [illegible] experience and not necessarily capable of designing but able to detail ordinary work.

Tracer, Class A—Either with college education or with two and one-half years' experience and capable of doing good work.

Tracer, Class B—Without college education or experience. Salary to increase $5.00 every six months as long as he continues to [illegible].

Assistant Engineer or Engineer Inspector—In direct charge of important and difficult work, having others under his charge.

Assistant Inspector, Class A—Reporting to assistant engineer or engineer inspector and capable of handling important work.

Assistant Inspector, Class B—Reporting to assistant inspector, Class A, or to Assistant Engineer or Engineer Inspector and capable of handling less important work.

Instrumentman—In direct charge of field party and responsible for technical field work.

Rodman, Class A—[illegible] field work and [illegible].

Rodman, Class B—[illegible] and has little or no experience.

Tapeman, Class A—[illegible] and one-half years' experience and capable [illegible].

Tapeman, Class B—[illegible] improve.

In explanation of the salary schedule the brief further states:

"It will be noted that the minimum scale of salaries submitted above is very moderate. In proof of this we give below the scale granted by the Wage Board to the Marine Draftsmen in the private and in the Government shipyards [illegible]:

Chief draftsman	[illegible]
Leading draftsman	[illegible]
Draftsman, Grade A	$[illegible].60 per day—$250 per month
Draftsman, Grade B	[illegible]
Copyist	$5.6[illegible] per day—$145 per month

[illegible]

[illegible]

Civil service rules regarding vacation, holidays and sick leave.

"It is generally agreed by marine draftsmen that no higher technical knowledge or skill is required to perform [illegible] work than that which is necessary to do work in the railroad engineering department.

"We hold that the employe has a right to more than what is commonly known as a living wage. We hold that all the fruits of labor should be enjoyed by those who work with head or hand and by their children, to the end that the members of society may [illegible] toward greater perfection [illegible] the elevating influences of music, art, literature, science and [illegible] all of perfect [illegible]. [illegible]

[illegible] We, as workers in the great technical [illegible] of applied science, know that our efforts result in a greater production for a given expenditure of energy. We delight in our labors because we are conscious of this fact. Sometimes it is the very love of the work itself that holds our interest; but [illegible] and [illegible] that out of the struggle to accomplish against drudgery will come a greater joy to ourselves and to all humanity. If on the other hand, we see ourselves imposed upon, our strength sapped because of excessive application to routine performances, our salaries insufficient to care rightly for ourselves and for our children, to whom all future surplus properly belongs; in other words, if we of the great mass of workers are con[illegible] toil while the few take and use for themselves what we make, then all joy and contentment must of necessity be [illegible] hope that at some time through our continuous efforts we shall be able to right this great wrong."

Further information regarding the suggested classification is given in the brief as follows:

"It will be noted that the salaries requested are all minimum. Taking the Chief Draftsman as an illustration, for instance no Chief Draftsman on any road under federl control would receive less than $300 per month. It is undoubtedly [illegible] the average man should naturally find himself in a smaller and less responsible office at lower salary than that in which a man of exceptional ability is located at a higher salary. Again, an exceptionally expert tracer on all kinds of intricate work, wherever there is a demand for [illegible] per month set in above minimum scale. As another illustration [illegible] designing anything in his line of work. Now, there will be a wide range of such men, from those below the average to those above. No Class A draftsman would receive less than $210 per month, but the exceptional expert may receive much more than that. There is no reason why an expert in one line should not receive as much, or even more, than a medium man in another position which is commonly considered to be 'higher up.' The erroneous conception has been growing all too prevalent that the man who possesses ability to manage is 'higher up' than another who has no qualifications along that line. This conception has been operating to the detriment of the lofty aims and fundamental purposes of engineering and architecture. Since when has the artist, the musician, the mathematician, the scientist become a manager? All engineers know that some Chief Draftsmen and engineers in charge of departments have drifted away from technical engineering and become clerical operatives, and directors, while the real technic of engineering, the application of science, is done by what they are pleased to call their 'subordinates.' The idea of subordination is a bad idea. It militates against personal freedom and the true and beneficial spirit of co-operation. Let us recognize true merit and [illegible] at all for any of the positions mentioned."

Further extracts from the brief follow:

[illegible] that the Board of Railroad Wages and Working Conditions [illegible] roads, that he issue a general order to all railroad companies under federal control, said order to require these railroad companies to grant to the duly accredited representatives of the International Federation of Draftsmen's Unions [illegible] representatives of all other organizations of technical engineers and architectural workers the following rights:

[illegible]

"2. The right to secure from the proper railroad officials complete lists of the names, addresses, titles, and places of employment of all technical engineering and architectural workers in their employ.

"3. The right to enter the various places of employment of such technical workers during the lunch period for the purpose of carrying on individual organization work.

"**Pro Rata Furlough.**—Reports of men being discharged from the engineering service of some of the railroads have been coming to our notice for the past two or three weeks. We request, therefore, that your Board recommend, as soon as possible, to the Director General of Railroads that he issue a general order without delay to the effect that, if any reduction in operating expenses of the engineering departments of the railroads must be made a pro rata furlough without pay be granted to provide for this necessary reduction, rather than discharging or reducing the rate of wages of employes; and also that he direct that workers discharged or demoted be reinstated wherever they so desire.

"**Permanent Regulatory Committees.**—We request that machinery be perfected and set in motion for the formation of permanent regulatory committees in every railroad company under federal control, such committees to be composed of the various heads and subheads of the engineering departments. As an illustration, take the bridge department: the regulatory committee of this department would consist of a representative from the railroad managers, the Chief Engineer, the Assistant Chief Engineer, the Bridge Engineer, the Chief Draftsmen, and the directors of the field forces. The duties of this particular committee would be to prepare a budget of the work and of the forces in the department necessary for carrying on the working during the coming fiscal year. Representatives from these various committees of each railroad could confer with similar representatives from other railroads or a national railroad committee could be formed, composed of representatives from all the railroads. The duties of this national or regional committee, if this is thought better, would be to so adjust the engineering forces to the work to be done on each railroad system so that if one company had more engineering workers than they needed temporary transfers could be made to other companies who have a lack of such forces. It could be arranged also so as to be satisfactory to each individual worker. We do not, by any means, intend to convey the impression that we have worked this regulatory committee proposition out in detail. We merely offer it as a suggestion. We want something to be started along this line so as to regulate and stabilize the work of the engineering departments so that it will not be as spasmodic as it has been in the past; and we believe that whatever scheme is devised, the men who have actual and personal contact with the forces who do the actual technical work should form a part of the general plan of control.

"**Overtime.**—We consider the practice of requiring overtime to be productive of bad results, tending to destroy freedom and the pursuit of wholesome natural inclinations of general interest. We hold that wherever an individual desires to devote the whole of his time to his particular specialty, it is his privilige to do so. There may be danger of his getting out of touch and out of sympathy with those things which are of general human interest, but that depends largely upon his individual character; however, this will be done of his own volition, and nature has the benign habit of often correcting its own faults. Such work as is done outside of regular hours of one's own choice and desire does not constitute overtime in the sense implied in this brief. Wherever an employe is requested or ordered to work in addition to the regular time, or, on account of the peculiar circumstances under which he is placed in a trip, say away from headquarters when he can not very well avoid overtime, or when he is required to finish a certain piece of work by a certain time which it is physically impossible for him to accomplish during regular hours, if he is to do the work right and satisfactory to his own conscience—this constitutes overtime and should be paid for at the rate of time and one-half to discourage its practice. We contend that the perfect human being is the ideal toward which we strive. Required overtime tends to destroy this ideal. Our duties, rights and pleasures are many and varied—and 'variety is the spice of life.' We do not wish to be mistaken, either. We do not look upon our tasks as irksome. Sometimes they are, and we are honest enough to admit it, but frequently our tasks are the greatest source of pleasure of our lives—when the work is interesting, constructive, instructive, and creative. Then we are not ready for the whistle to blow. We take our work home with us in our minds and dream over it. We do this all of our own free will and accord. We are opposed to enforced overtime at any rate of pay, except where it is absolutely necessary; and then as a safeguard against its practice it should be paid for at the rate of time and one-half.

"**Organization.**—In investigating the causes for the lamentable fact that most engineering and architectural workers of the rank and file employed on the railroads are miserably underpaid, we have arrived at this conclusion—the most potent cause lies in the fact that these workers have been heretofore unorganized. They can not speak individually. The individual voice is hardly ever heard. Collectively, never before until now, have they spoken. The Chief Engineer of a railroad, though he felt disposed to do so, knows that to request a general raise (that is, a real and not a camouflage raise) for those employed in his department, means increase in operating expenses and a consequent decrease in dividends. Inasmuch as he is generally a stockholder and the managers are stockholders, his economic and financial interests, the way he generally looks at it, are intimately bound up in trying to keep down operating expense and keep up dividends. Consequently, even though he sees the need and sees the justice of the cause, nevertheless there is that great urge which draws him toward lower operating expenses as the magnet draws the iron, and, to use a mixed metaphor, he is caught as a fly in a spider's web. He is placed in a very embarrassing position. We want to set the chief engineers free. We, too, want to reduce operating expense. It is to our interest as well as to them to do so—but not at the expense of wages.

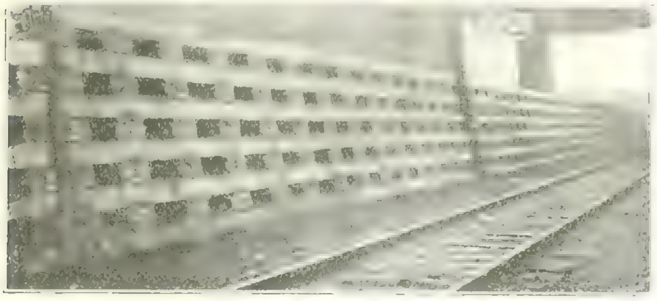
"We have read the transcript of the proceedings before your Board on March 31, April 1 and 2, 1919, regarding 'Wages and Working Conditions of Employes of the Engineering Department of Railroads Under Federal Control.' We note that on page 220, 221, 257 and 258 members of your Board, by their questions showed clearly to our minds that employes in the engineering department are shamefully neglected and underpaid on account of the fact that they have not heretofore been organized. For instance, one of the members of the Board put the following question, 'How can you account for the very meager salaries and the failure to recognize the integrity of these men and their capability, and yet they are the lowest paid men, skill, knowledge and ability considered, of any class of employes that work any place that I know of?' To this question Mr. Stevens, Chief Engineer of the Northern Pacific Ry., replied: 'I think Mr. Dermody answered that question in the remark that they lack organization. The engineering department is in a very embarrassing position in going before the management and stating that these men are underpaid. They say, 'Your predecessors got along all right. Do the men kick?' 'Why, no; the men haven't said anything.' That is the argument. Another member of the board made this statement: 'Now, if it had not been for labor organizations the civil engineers would not stand a show to get their wages raised now, because labor organizations have done these things."

Loosening Ground with Explosives in Trenching.—In trenching for 1,648 ft. of 5¼ ft. circular reinforced concrete sewer at San Francisco, black powder was used in breaking up the ground. The trench opened was 7 ft. wide and practically 20 ft. deep for the entire length. The material excavated was a very hard clay that stood alone without timbering or any other support. Black powder was employed to loosen the ground; the material thus broken was shoveled into 1-yd. buckets and hoisted to surface by a steam derrick. The charge employed for breaking the ground was 1 lb. black powder to a vertical hole of 4 ft. deep and drilled in the center of the trench. These holes were drilled at 5 ft. intervals. The trench was dug in 5-ft. steps. This charge merely loosened the ground so that no picking was required. The sewer was located in an easement through private property for 1,200 ft. on a side hill slope through a eucalyptus grove. The trees averaged from 60 ft. to 80 ft. in height. The contractors had the right-of-way cleared of these trees ahead of the excavation. The clearing was done by a subcontractor who accepted the felled trees in payment for the work. A portable ½-yd. mixer, set up on the edge of the trench was employed in the concrete work. The trench being 20 ft. in depth, enabled the concrete to be chuted in place for 50 ft. each way; 100 ft. of forms constituting a full day's pour.

A New Type of Sectional Concrete Retaining Wall

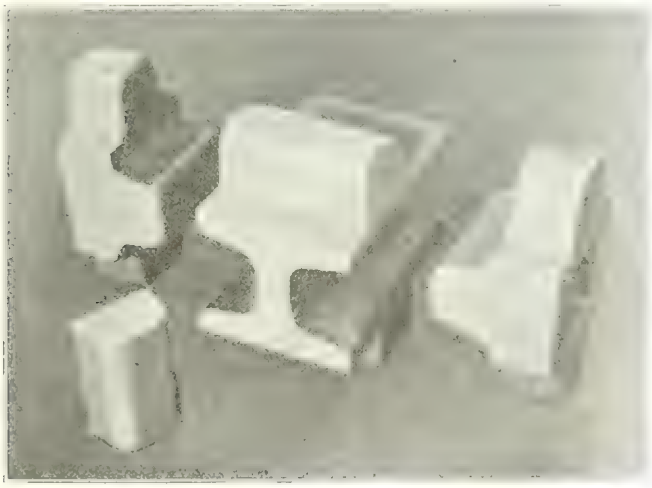
The engineers of the Cleveland & Youngstown R. R., a new suburban electric line running out of Cleveland, have developed a new type of sectional concrete wall, to conform to peculiar conditions in that city where, on account of contemplated terminal improvements, it was very desirable that certain parts of the electric line construction should be temprorary.

This type of sectional wall is essentially an 8-in. I-beam of reinforced concrete, but with additional cast concrete pillow blocks and fillers which are for the purpose of increasing the bearing area between headers and stretchers, especially where the wall is to be of considerable height.


Sectional Concrete Retaining Wall in Permanent Form, Cleveland & Youngstown R. R.

Each intersection of header and stretcher involves the use of two of these pillow-blocks and one filler block, the latter corresponding to the lug cast across one flange of the stretcher for the purpose already mentioned. In assembling these parts the headers and stretchers are put in position and the filler and pillow-blocks are inserted with sufficient grouting to make a unit structure and give a substantial bearing. In the completed wall this results in a series of substantial columns from bottom to top capable of carrying any load that is likely to be imposed on a structure of this kind.

Headers and stretchers may be made in any convenient length. In the illustration, the headers and the resulting columns appear at 3-ft. intervals. It is to be observed, however, that only one-half of the apparent total number of headers in the completed wall are used, each alternate header being a dummy only 12 or 14 in. in length. The manner of assembling is such as to stagger the dummy headers with the full length headers so that while the vertical bearings lines are preserved, no element of irregular lateral stability is introduced. A further precaution whereby to secure this same result lies in the staggered joints of the stretchers.


Details of Pillow Blocks and Fillers Used in Sectional C[illegible] Retaining Walls.

In setting up the walls as illustrated a batter of 2 in. per foot has been allowed. This is provided for in the slope of the first series of headers and follows thereafter in the progress of construction as a matter of course since the supports of the inner end of the headers are 8-in. sections corresponding to the stretchers themselves. Back filling proceeds as the wall is built up, preferably with some porous material such as cinders.

The claims made for this form of construction by the railway engineers are outlined as follows in the Railway Review, from which data and illustrations have been taken. Simplicity in form, cheapness and the rapidity with which it may be erected, combined with its dependability gives it a very pronounced advantage over the solid retaining wall that it is designed to supplant. In preparing foundations it is necessary to go no further than the frost line. Permanent drains need or need not be installed, depending on local requirements. Common labor is all that is required under the direction of a foreman to erect a wall of this nature. Curves may be followed or angles introduced without the necessity of special shapes or forms other than those used in straight way constructing. The sections as employed weigh 26 lb. per lineal foot and about 3 lin. ft. of the standard section are required per square foot of wall area. It is estimated that a retaining wall of this type ordinarily can be erected at about one-third of the expense of a solid wall serving the same purpose.

Modern Appliances in Street Railway Construction

A recent contract job in Denver, Colo., furnishes an illustration of how up-to-date equipment gives speed and economy in constructing electric railway track. Mr. W. L. Whitlock, Office Engineer of the Denver Tramway, writing in the Electric Railway Journal, states that his company departed from its usual practice in that it let the track construction end of the job by contract, something that had not been done on this system for 15 years. The contract was let on account of the scarcity of labor and the necessity for completing the work within a specified time. All of the rail, ties and special trackwork had been purchased and delivered, and as the Public Utilities Commission had ordered the work done there was only the labor shortage to prevent its speedy completion. The tramway allowed the contractor the use of its track construction tools and equipment in order to facilitate the work.

The equipment is listed below, and the list is interesting as an indication of the advance made during the past 15 years in the art of track construction. It comprised one 5-ton, one 3-ton and one 1-ton auto truck of the self-dumping type; pneumatic paving and concrete cutters; 3-ton crane car; oxy-acetylene cutting outfit; reciprocating and Atlas rail-grinders; Indianapolis arc welder; concrete tram; mechanical pusher for unloading dirt from flat cars; portable rock crusher and conveyor; Lincoln bonding machine; pneumatic tie tampers; portable crossovers; temporary lamp clusters, and camera for making progress records.

The largest layout of special work, located at Broadway and Colfax St. intersection, was of 100-lb. A. R. A. rail, cast-manganese construction. The special work at the other three locations was likewise of cast manganese but of 80-lb. rail section. All of the special work was built by William Wharton, Jr., & Co. The tangent track construction consisted of 80-lb. A. S. C. E. rail, with Apex-welded joints and International twin steel ties. The entire track structure was imbedded in concrete of a 1:2:3 mix, using crushed rock as the aggregate. The cast-manganese layouts already mentioned were supported on 9 in. of crushed rock ballast and long-leaf Texas pine treated ties. The paving was 1:2:3 concrete also with crushed rock aggregate. All of the construction was in streets paved with asphalt.

Increase in Living Costs During War Period. Living costs increased 61.3 per cent between July, 1914, and March, 1919, according to a report issued recently by the National Indus- [illegible] Board; [illegible] various items of the family budget were:

[illegible]

[illegible] States.

Safety Rules for Quarrying

Safety rules drafted by eight practical quarrymen and based on actual quarry records have been issued in poster form by the National Lime Manufacturers' Association. The rules are as follows:

(1) Reporting Injuries.—In case of accident, no matter how slight, even a slight cut or break of the skin, report to your foreman at once and have it taken care of in a clean way. During 2 years in one state 721 men suffered from infection and blood poison. About [illegible] of these cases resulted from neglecting small cuts, bruises, slivers, scratches, and nail punctures of the feet.

(2) Loose Rocks Overhead.—When working in the quarry always look out for loose rocks above which may fall and injure you. A small rock the size of your fist, if it falls 30 ft. may kill you.

(3) Rocks Fall from Piles.—Be careful when working around piles of stone. There is always danger that a rock may become loosened and fall and strike you.

(4) Stepping on Stones.—Before stepping on a stone always look to see that it is solid. A rocking stone may cause you to lose your footing and fall and break your leg.

(5) Hoisting Stone.—In hoisting stone with the derrick, there is only one safe rule for the men in the quarry to follow. Don't stand under. The moment the stone starts to rise, get away to a safe distance.

(6) Swinging Derrick.—When working near the derrick always look out for the swinging boom. You are liable to be struck and injured by the stone or chain.

(7) Talking to Hoistman or Signal Man.—It is always dangerous to talk to the hoistman or signal man. Remember that if you attract their attention away from their work for only a minute it may cause them to make a serious mistake and the lives of the men in the quarry may be in danger.

(8) Dragging Stone.—In dragging stone, don't stand in front. The cable or hook may break and strike you, and don't jump on or ride stone trucks; the temptation is great, but the danger is greater.

(9) Wedging Stone.—In wedging stone apart, always insert a stone or wedge in the break before you insert your hands. When driving wedges stand in line with your break; many have been severely crushed by the stone falling sideways.

(10) Protect Your Eyes.—Sledgers and others who work where chips and small particles fly in the air, should wear spectacles to protect their eyes. Remember, you have only two eyes, and one or both may be blinded by a small chip.

(11) Walking on Tracks.—Be careful when walking on the car tracks. You are always in danger of being struck by the cars, and don't kick chocks out from under cars with foot; drive out with bar.

(12) Mushroom Heads on Chisels.—Mushroom heads on chisels are always dangerous for the reason that when struck by the hammer a small part may be broken off and fly in the eye. Many men have lost an eye because they did not properly grind the heads of their chisels.

(13) Danger at Bottom of Incline.—When the car is going up the incline of the crusher or kiln don't follow it or stand on the track at the foot of the incline. There is always danger that the cable may break or some other part give way and you may be struck by the car and killed.

(14) Sledges Caught in Awning.—Paving cutters should be careful to construct their tents high enough, so that in working, the sledge hammer will not catch in the canvas and cause an accident to yourself and others.

(15) Blasting—Warning.—The whistle or warning always blows, or is given before a shot is to be fired. When you hear warning don't wait—don't take a chance—but at once run to a safe place.

(16) Report Dangerous Conditions.—Every man in this quarry is requested to report to his foreman any condition or any dangerous practice which he thinks may cause an accident. The only way to have a safe quarry is for every man to do his part.

How to Handle Dynamite and Caps with Safety.—The handling of explosives is dangerous business. Every man should observe the following rules:

(17) Forcing Primer.—Don't force a primer into a bored hole.

(18) Smoking Forbidden.—Smoking while handling explosives is strictly forbidden.

(19) Don't Let Explosives Fall.—Don't throw or allow boxes of explosives to fall violently.

(20) Use Wooden Tamping Sticks.—Don't do tamping with iron or steel bars or tools. Use only the wooden tamping sticks provided for this week.

(21) Care of Explosives.—Don't allow explosives to lie around loose in places where you are working.

(22) Caps Kept Separate from Dynamite.—Don't leave blasting caps in the same box or close to dynamite.

(23) Don't Carry Caps in Pocket.—Don't carry blasting caps in your pocket, and don't tap or otherwise investigate same.

(24) Removing Blasting Caps from Box.—Don't attempt to remove blasting caps from boxes by inserting nails or any sharp instrument.

(25) Biting Caps Is Dangerous.—Don't tighten a cap around a fuse by biting it with your teeth, nor by using a pocketknife. Use a cap crimper which is provided for this purpose.

(26) Frozen Dynamite Dangerous.—Don't use frozen or chilled dynamite. Don't cut or break a piece of dynamite while it is frozen.

(27) When Dynamite Fails to Explode.—If a charge of dynamite fails to explode, don't go near it for one hour, it may go off and kill you.

(28) Thawing Dynamite.—Many men have been killed while thawing dynamite. The following two ways of thawing dynamite are safe:

(a) One of the safest and cheapest ways to thaw dynamite is to bury it in a pile of manure.

(b) Use the regular dynamite thawer which is provided, and which if properly used is safe. Don't under any consideration attempt to thaw dynamite around an open fire.

Estimating the Life of Special Track-Work on Curves

Mr. M. Bernard, writing in the Electric Railway Journal, gives his experience in an investigation on one of the large Eastern electric railways in which he arrived at some interesting rules by which to gage the probable life of curved track work.

In a study of special work layouts with reference to their most economical design and also in the determination of schedules of future renewals extending over a period of years, it is clearly advantageous if not absolutely necessary to have a knowledge of the probable life of special work.

The age and life records of more than 100 curved special work layouts were investigated from which it appeared that the life of such layouts varied in the following manner:

Special work in which the life is determined by the curved component parts has a life expressed in terms of years approximately equal to the number of the template required for plotting the curve, the standard scale being 1 in. equals 8 ft. Thus with a connecting curve having a radius of 40 ft., as the plotting would require the use of a No. 5 template, the life could be approximately 5 years under average conditions, say, 100,000 cars per year.

Expressed in more general terms, the life of curved special work in terms of years is equal to the radius in feet divided by eight. From the investigation it was found also that the average life in terms of cars is equal approximately to 12,500 cars for each foot of radius. Local conditions should, of course, be given some weight in deciding on the probable "car-life," such as intensity of traffic speed of cars, etc.

A comparison of the varying car traffic at a large number of locations disclosed a tendency for special work of the same general type to have a greater car life at a location having a traffic of, say, 50,000 cars annually, than at a location where the car traffic amounted to 150 000 cars. This is analogous to the fact that material which fractures under 20 blows delivered in one minute will withstand more than 20 blows if these are spread out over 2 minutes. For similar reasons special work over which the maximum speed is 6 miles per hour will have a greater car life than where the speed limit is 12 miles per hour. As a rule a trailing tongue switch and mate will have less life than a facing tongue switch and mate in the same double-track branch-off. In any study of the relative efficiency of special work the question to be decided should not be the life expressed in terms of years but rather the life expressed in terms of car wheels. The rule described in the foregoing will not apply, of course, where the traffic over the straight is far in excess of that over the curved run.

Stripping on Cuyuna Range by Hydraulic Sluicing Method

By EMERY S. HILL

The following method is used in stripping the Hillcrest open pit iron mine on the Cuyuna range.

Water is pumped ½ mile through 12-in. spiral riveted pipe to the pit where it is nozzled down to 3 in. and directed by a laborer against the spoil bank, the pressure at the nozzle being about 65 lb. per square inch. The material, consisting of sand and gravel, is washed to a sump from which it is pumped by centrifugal sand pump, or "sand sucker" and forced to the top of the pit, about 100 ft. in height, through spiral riveted pipe and from there a distance of about 1,200 ft. to the waste dump. The coarse stones, roots, sticks, etc., are removed from the material before it reaches the sump by a grating with bars 4 in. apart. The sand pump handles stones up to 4 in. in diameter. Two men stationed at this grating keep it free from debris by using forks and rakes. Material not handled by the pump is loaded into dump cars by a steam shovel.

The sand pump is direct connected to a 300-HP. 2,200-volt, alternating current, variable speed motor which consumes an average of about 90 amperes. The pump, motor and accessories are placed in an old box car. An attendant is required at the motor, his principal duty being to vary its speed, in accordance with the signals from a man stationed at the sump. These signals are given by means of a gong.

The shell of the pump is made from charcoal iron and lasts an average of about 6 weeks, its life depending upon the coarseness of the material pumped. In extremely coarse material one shell lasted only 9 days. The runner is made from cast steel and usually lasts about 6 weeks. A foot valve is used at the end of the suction pipe. The pump is primed by filling it with water piped from the line conveying the clear water to the pit. A 2-in. check valve is attached to each line at its highest point to prevent the pipes from colapsing should the pumps stop.

Whenever the discharge pipe begins to show small leaks on its under side, indicating that it is nearly worn through it is revolved a distance equal to one-third of its circumference

The water used in washing down the material is pumped to the pit by a 2-stage centrifugal pump direct-connected to a 300-HP., 2,200-volt, alternating current variable speed motor consuming an average of about 60 amperes. The pressure of the water at the pump is 145 lb. per square inch by gage. The water is admitted to the end of the suction pipe through a short channel (widened where the suction pipe enters it) having planked sides. Sticks, moss, etc., are kept away from the intake by a removable screen 3 ft. x 5 ft., constructed from heavy wire netting having ½-in. mesh, set in a wooden frame. The attendant at the pump removes the debris collecting in front of the screen by means of a rake.

To prevent whirlpools forming at the end of the suction pipe a float is used made from two 1-in. boards 2½ ft. long and 12 in. wide fastened to cleats so that their inner edges are 6 in. apart. These edges are hollowed out to form a hole about 6 in. larger than the diameter of the suction pipe. The 12-in. suction pipe is inserted through this opening. The float constantly revolves and effectually stops any vortexes that develop.

By the above method 87,000 cu. yd. of material are claimed to have been removed in 42 10-hour shifts.

Some Modern Tendencies in Roundhouse Design

Mr. Edwin M. Haas of the Austin Co., Cleveland, O., recently presented a paper before the Western Society of Engineers on the above subject, in which the following points were brought out:

The great increase in traffic, operating charges and hauling capacity of locomotives and their cost have proportionately increased the demand for the full utilization of an engine's earning power, which is vitally affected by the improvements in the roundhouse and adjacent facilities.

The shortage of capable help and the increasing cost of all labor are tending toward the installation of labor-saving machinery, as well as the bettering in many ways of the working conditions for the men. Better illumination is important as affecting the production per man. The use of bridge and jib cranes is increasing. Improved heating and ventilating also affect the human element.

In the smaller and cheaper roundhouses where wooden truss roofs are used, the tendency is to build up the trusses with bolted planks in order to cheapen the construction without reducing the quality of the lumber.

Reinforced concrete houses, the use of which is increasing, are [illegible] built [illegible] the columns. These columns are sometimes of structural steel encased in concrete, when jib cranes are to be installed.

The [illegible] are of steel, and with [illegible] lating sections. Experience seems to show that the steel sash are longer lived than the wooden sash and are nearly as cheap; they have the additional advantage of not swelling under excessive moisture, making the ventilators work easily both summer and winter

Another tendency in roundhouse design and construction which has come into more general use in the past few years is the substitution of the hot blast heating system for the pipe coils or other forms of direct radiation. A hot blast heating system installation costs very little more than a direct system, and it has the additional advantage of providing forced ventilation in the house, which is often very necessary. At first the selection of too low fan and radiation capacity resulted in the indirect system being unsatisfactory. These have been corrected, and [illegible] extremely cold weather to raise the temperature for thawing out frozen locomotive [illegible].

Mr. Haas calls attention to the growing tendency to substitute the electric hoist for the truck and driver drop pit. In addition to reducing liability of accidents it removes wheels more quickly and cheaply. While this hoist is sometimes installed in the roundhouse, its proper location is in the back shop. In any case, the back shop should be connected with the roundhouse by a passageway, lined up with the turn-table, so that the dead locomotive can be pushed through the house into the back shop. With the electric hoist in the shop section, the removal of wheels is under proper supervision, and the handling of repair parts to and from the various machine tools is for but a short distance. Placing the hoist in the back shop also releases a stall for regular roundhouse service Serious objection to the drop pit has developed in recent years, owing to the extremely heavy locomotives and to the declining quality of roundhouse help. While accidents due to [illegible] greatly increased with the failure to obtain intelligent labor.

Grade Crossing Elimination in Relation to Permanent State Roads

State Highway Commissioner Lewis S. Sadler of Pennsylvania is quoted in Concrete Highway Magazine as having announced that counties interested in the building of permanent state roads crossed and recrossed at grade by railroads will get little encouragement from the State Highway Department as long as the grade crossings exist In receiving a delegation from Bedford County not long ago, Commissioner Sadler said: "I will be frank with you gentlemen when I tell you that there does not seem to be a chance [illegible]

Commissioner Sadler's attitude supports rapidly growing public sentiment that where at all possible, highway grade crossings with railroads be eliminated.

[illegible] ing menace. There is an opportunity for more getting together on the part of highway and railway officials in the solution of the grade crossing problem. The briefest study of the general problem leads one to believe that one thing urgently needed is more uniformity in state laws relating [illegible] days of motor traffic many crossings have proven very expensive for the railroads, since expensive litigation frequently follows a crossing accident and the railroad company is often [illegible] the automobile was in the wrong

Relationship of Construction Industry to American Business

The total annual expenditure in the United States in normal times in connection with construction is in the neighborhood of $[illegible] according to a report prepared by Mr. W. T. Rossiter, president of the Ohio Builders' Supply Association. The construction industry, according to Mr. Rossiter's data, is the second in the country, not only from the standpoint of materials produced and the tonnage furnished to the railroads, but from the great number of persons employed. Mr. Rossiter's figures follow:

The following figures are computed from the 1910 reports of the Bureau of Census which includes a tabulation of male occupations for the year 1910, in which 30,091,564 men are reported as employed:

[illegible]	10,8[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	30,091,564

It will be noted that those employed in the building trade number 4,269,466. To this number must be added 25 per cent of the total employed by the railroads of the United States, since, as shown below, roughly 25 per cent of the total tonnage moved by the railroads consists of construction material. It will be seen that transportation employs, roughly 2,500,000 men; 25 per cent of that number is approximately 630,000 additional men who are employed because of the construction industry. Furthermore, statements by the Fuel Administration and other authorities indicate that approximately 30,000,000 tons of coal are consumed annually in the production of lime, cement, brick, clay and gypsum products. It would be necessary, in order to obtain the total number of men employed because of the construction industry, to take a proportion of those employed in forestry, in the extraction of minerals, retail dealers, in professional service, in clerical occupations and some listed as unclassified, such as wholesale dealers, etc.

The following comparative figures on railroad tonnage are taken from the Interstate Commerce Commission Report for one year ending June 30, 1916:

	Tons.
[illegible]	112,160,531
[illegible]	[illegible]
[illegible]	748,651,092
[illegible]	20,569,[illegible]
[illegible]	136,246,71[illegible]
[illegible]	117,759,[illegible]
	1,149,842,297

The following figures show the relationships between values of the principal materials used in the construction industry; these figures were obtained from reports received by the U. S. Geological Survey for the year 1916 and are in the terms of the value of the finished product at the plant:

[illegible]	$[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
Portland cement	104,689,090.00
[illegible]	18,618,81[illegible]
Sand, lime, brick	1,474,073.00
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
Structural steel	227,247,300.00
[illegible]	[illegible]
	$1,348,799,905.00

In calculating the cost of labor entering into construction, the percentages of the several materials employed in typical construction were taken, together with the percentage of the direct labor involved in producing the material as reported by the several industries. In the final compilation, without including labor employed in transportation, it was found that about 80 per cent of the entire cost of producing the material and assembling it in finished construction is labor.

It is evident that the cost of construction cannot be expected to decline unless there is a corresponding decrease in wages rates, which should not occur if the American standard of living would thereby be lowered.

Mr. Rossiter concludes his report with the following pertinent observation:

"Technically, if we base all our figures on a 70 per cent normal basis and assume that half of the 70 per cent of the entire construction industry is now in operation, the country would still be suffering from the following losses:

Freight tonnage	10,000 cars per day
Financial loss	$5,000,000 per day
Unemployment (direct)	1,500,000 men

while, if the industry were operating on a 100 per cent basis, it would mean that over 2,000,000 additional men (direct labor) would be required."

Efficient Method of Renewing Decking on Long Viaduct

Engineers of the Milwaukee Electric Railway & Light Co., in renewing the timber decking on a long viaduct in the city of Milwaukee, Wis., employed a method of procedure both novel and efficient. The work was done the past season when labor was difficult to obtain. This in addition to the requirement of interfering with traffic as little as possible, made the problem a serious one. The organization of the work and appliances used are described in Electric Traction as follows:

The way and structures department of the road conceived the idea of preparing the decking in sections and placing these in position with a derrick during the progress of the work. By this means the entire 2,060 ft. of decking for one track was removed and replaced ready for the laying of rails in a space of time involving slightly less than 10 days. This was accomplished with a crew of 25 men.

Over 200,000 ft. B.M. of Washington fir timber was used in the new decking. All timber was framed and bored before subjecting it to treatment with creosote. For this purpose an electrically operated boring machine was improvised at the material yard. Bolt holes for securing the timbers together in sections and for securing the sections to the structure were drilled with this machine, using a template. Spike holes were also drilled.

After drilling and framing was complete the timbers were assembled into bundles for treatment with creosote. This treatment consisted of dipping the bundled timbers into a tank specially prepared for this purpose. The tank was constructed of steel plate and was made large enough to receive a bundle of 24 ties. The timbers were prepared for immersion by securing them with strips of angle iron. A "drip platform" was erected at one side of the creosote tank in order to set aside a treated bundle while another bundle was immersed. The previous bundle was then placed on top of the bundle in the tank to hold the latter down and also to allow the drip to run back in the tank. The creosote oil was kept hot by means of steam coils placed on the floor of the tank.

When preparations were completed, traffic was diverted entirely onto one track and the work of removing the old decking was begun. The running rails and steel guard rails were first removed with the help of the derrick and were disposed of for the time being by setting them between the rails of the operating track. Old ties, timber guards and planking were removed and loaded on cars which were then pulled to a nearby material yard. The power derrick then picked up the 14-ft. sections, transported them to position, and swung them into place, thus eliminating a large amount of hand labor and making possible the remarkable speed attained in replacing the decking and restoring the bridge to a condition to accommodate traffic. An additional factor contributing to the speed of the work was the offering of a bonus to the men for completing the work within specified conditions.

After the completion of the first track by this method, traffic was diverted over the new construction and the method repeated on the second track. The time required for this work was practically the same as that for the first track.

From the standpoint of labor saving, the method is obviously very efficient. From the standpoint of speed the efficiency of the method can best be illustrated by reference to the record of the 25-man gang on one of the closing days of the work when the men were thoroughly organized and working to the best advantage on account of being more familiar with the method. On the day referred to, 30 sections of decking, totaling 405 ft. of new deck, were placed on the structure.

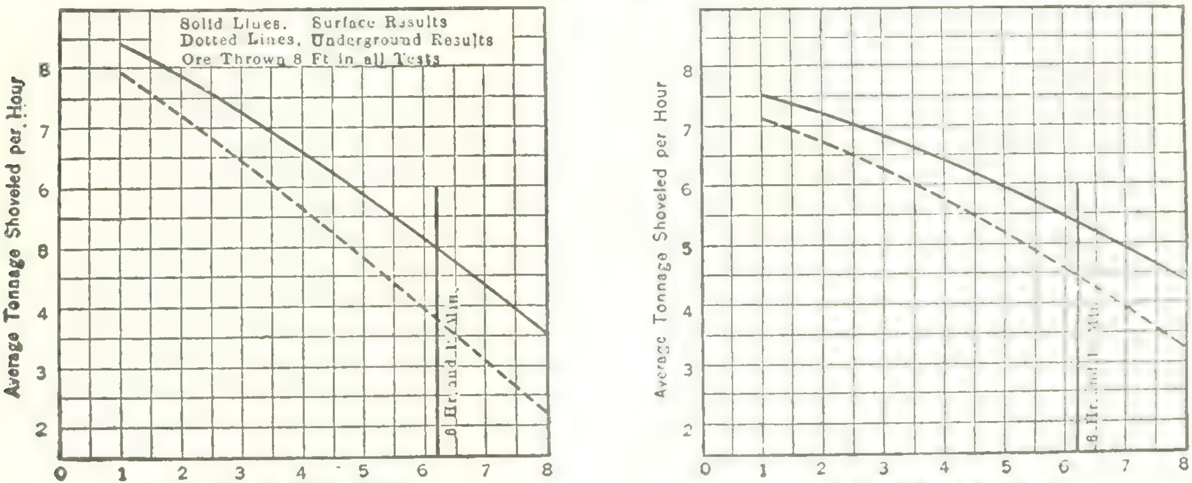
MANAGEMENT AND OFFICE SYSTEM

This section is published twice a month: (1) In the Waterworks and Hydraulic Monthly issue, and (2) in the Railway and Excavation Monthly issue. It covers what may be broadly termed "management engineering" as applied in the civil engineering and construction fields.

The Application of Efficiency Engineering to Shoveling*

By G. TOWNSEND HARLEY,
Efficiency Engineer, Phelps-Dodge Corporation, Tyrone, N. Mex.

At the mines of the Phelps Dodge Corporation at Tyrone, N. Mex., the cost of shoveling in all stopes during 1917 amounted to 24 ct. per ton. In the top-slice stopes for the same period shoveling cost 27 ct. per ton., or 16 per cent of the total cost of these stopes. The average wage per laborer shift was $2.67 during the year under review. The tonnage for shovelers from all stoping was 9.3 tons per man, and for top-slicing 8.2 tons per man per day. These stopes were not unduly hot, and there was not more than the usual amount of timber to interfere with the work of the men. The tonnages obtained per shoveler were considered low; first, because of a poor grade of Mexican labor, many of the men having come in from railroad-grading camps; and, second, because of a poor spacing of raises, especially in the top-slice stopes where, in general, they were spaced 25 ft. by 66 ft. centers.



A - No.2 Eastern Pattern Scoop

B - No.4 Sq. Pt. D-Handle Shovel

Fig. 1—Average Tonnage Shoveled Per Hour

Preliminary Steps for Determining Shoveling Efficiency.—As a first step toward determining how the general efficiency of underground shoveling could be improved, several weeks were spent in a general survey of the field and making time studies on various men, to see what points would need to be determined for a full consideration of the subject. The following factors were soon recognized: The type, weight, size, and design of shovel giving the greatest shift tonnage without too much wear and tear on the man would have to be determined; a standard of comparison would be necessary if the ill effects of mine air, powder gas and smoke, temperature, humidity, and poor light were to be estimated, and the layout and spacing of chutes would have to be studied with regard to their effect on shoveling directly into the chutes, or loading into wheelbarrows or cars and tramming to them. This latter work would determine the proper distance at which shoveling into a chute should cease and loading into a wheelbarrow or car would begin, and the information would also be of great value in planning the development of a stope. Further considerations were: Hindrances [illegible] to obtain maximum results from them, number of men in [illegible] delays; capacity of a man for work as the day progresses; proper rest periods for men to maintain maximum efficiency; best means for instructing men and supervising work, and compensation received and manner of payment.

Three types of shovels were in general use at the mines. A No. 2 scoop, a No. 2 or No. 3 square-point D-handle shovel, and a No. 2 round-point long-handle shovel. [illegible] the average load that the various types and sizes of shovels would handle, so as to be able to decide the best load for the average Mexican laborer of the Southwest, average capacities were obtained by repeatedly shoveling a weighted pile of ore with each of the shovels and counting the number of shovel loads required to move it. It was determined that for Burro Mountain ore a [illegible] [illegible] 373 cu. in. and a No. 5 round-point shovel holding 340 cu. in. were used.

A time-study sheet was developed, which was used for all tests. In addition to the data placed on this sheet, an extensive log of the work was carried on, which undertook to explain, in detail, all delays, changes of work, rest periods, changes in conditions that would affect speed, high and low efficiency periods during the day, and other points to be [illegible]

Motion Studies Establish Standard Time and Performance [illegible] several divisions, each susceptible to comprehensive study [illegible] spent actually shoveling, time spent other than shoveling [illegible] and, consequently, a standard of performance for the whole. It was possible, also, to discover which were the most tiring motions and how each was affected by length of time worked, length and distribution of rest periods, size of shovel, design of shovel, and length of throw.

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*Abstract of a paper [illegible] meeting of the American Institute of Mining Engineers.

To establish a standard of comparison for the underground work, some of the mine shovelers were brought to the surface and a record of their work was made under ideal conditions, that is, with good air, good light, no timber to interfere, steady shoveling for various lengths of time, and standard lengths of throw for the muck. In addition to obtaining this comparison standard it was possible to form definite conclusions, which were later checked satisfactorily under actual conditions in the mine, as to the most advantageous size, type, weight, and design of shovels for general use, and under the various conditions encountered.

Tests of Shoveling Performance.—Tests were carried on for two months, three different shovelers, taken from the mine, being observed. Each of these men was warned that he had to work at his best speed, all during the job, but that he was not to overtax himself. He was told that when he became tired he was to take a few moments' rest, as it was better for him to rest at intervals than to try to work all the time, at the expense of speed and capacity. Later the rest periods were regulated, to obtain the proper intervals at which they should occur, and their length.

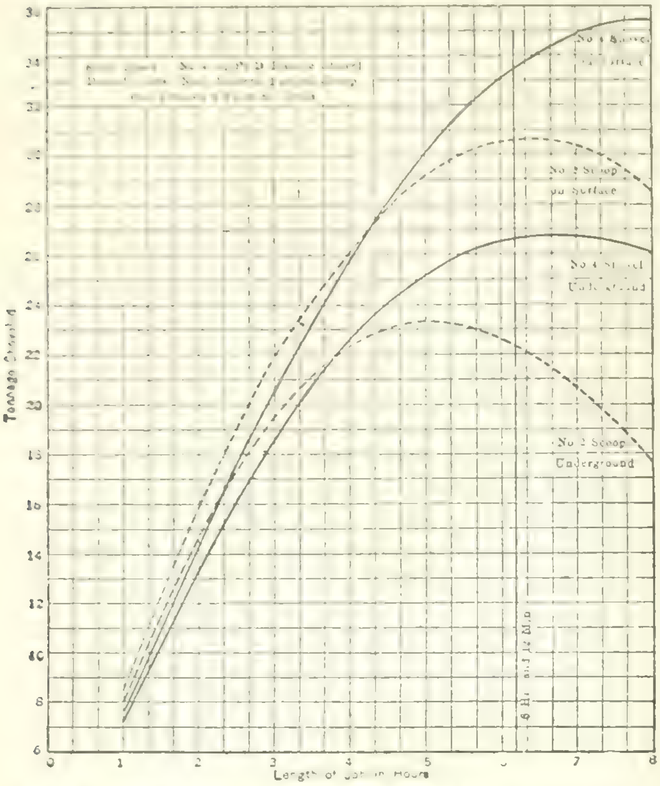


Fig. 2—Comparison of Work of No. 2 Scoop and No. 4 Shovel.

All of the underground shoveling tests may be classified under one of three headings: Shoveling directly into chutes; shoveling into wheelbarrows and tramming to chutes, and shoveling into cars and tramming to chutes. Each of these series was conducted independently of the others, and was complete in itself. The men under observation worked for periods varying from 1 to 8 hours, and for each length of job they threw or trammed the muck over a wide range of distances, with various types and sizes of shovels. In all the underground tests, the work was done under the actual mining conditions, with the one exception that the men were always under observation, and, consequently, were working at a good speed for the full period of the test. In no case did the men overtax themselves, and it is believed that all tonnages recorded are easily obtainable by a good but not exceptional Mexican laborer after he had been properly instructed, and under close and intelligent supervision, together with a wage paid in such a manner as to provide an adequate incentive to do good work.

It soon became evident that the great majority of shovels being tested were not suitable for efficient work, and only the work of the No. 4 shovel, which handles the 21-lb. load, together with that of the No. 2 scoop, which was held in high esteem by many of the men in the operating department was plotted on charts. The results obtained during the surface tests were plotted alongside of corresponding results from underground, to accentuate the adverse effects of underground conditions on shoveling capacity.

Effect of Type of Shovel and Length of Throw on Shoveling Speed. The number of shovels per minute thrown into a chute at a distance of 8 ft. from the ore pile, for jobs varying in length from 1 to 8 hours, is greater with the No. 4 shovel than with the No. 2 scoop. Both on the surface and underground the speed of shoveling decreases more rapidly with the scoop than with the shovel, as the length of the job increases. A man working with a scoop underground can perform at only [illegible] per cent of his speed on surface for 8 hours, whereas with a No. 4 shovel he can work at 82 per cent of his surface speed. The percentage reduction in speed between surface and underground work is the measure in part of the effect of mine air, powder gas and smoke, temperature, humidity, and poor light. Under the same condition of work, the difference in speed between the No. 4 shovel and the No. 2 scoop is due to the difference in the load handled.

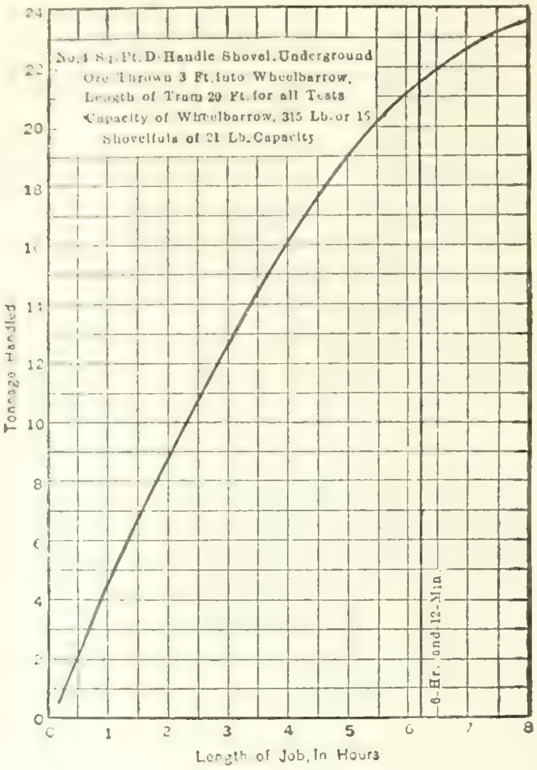


Fig. 3—Capacity of Shoveler Using Wheelbarrow for Various Jobs.

The manner in which the length of throw will affect the speed of the shoveler was worked out for a uniform length of job of 6 hours and 12 minutes, and for varying distances. The decrease in shoveling speed on the surface amounted to an average of 2.5 per cent for every foot increase in distance thrown in the case of the scoop, and 1.8 per cent for the No. 4 shovel. Underground, the working speed was decreased more rapidly, being respectively 4.4 per cent and 3.2 per cent per foot increase in throw. The rate of decrease in shoveling speed, both on the surface and underground, was greater for the heavily loaded scoop than for the shovel.

In determining the amount of rest required for shoveling jobs of various lengths it was found that the scoop again has a negative effect both on surface and underground, causing a man to use up more time in resting than when working with a No. 4 shovel. The rest period, as considered, was made of the time consumed in delays, the time actually spent in resting, during which the man may smoke a cigarette and sit down for a few minutes, and the time used in loosening the muck pile, scraping up the dirt on the shoveling plat, or doing other light work, not actually shoveling, but closely related to it.

Determination of Actual Time Devoted to Shoveling.—Over a long period it was possible to demonstrate the feasibility of accurately determining the percentage of the working day that a man will actually devote to shoveling. The working day at the Burro Mountain mines is 8 hours, ½ hour of which is given up to the lunch period, leaving 7½ hours as the total possible working time. It was found that of this 7½ hours the man actually worked at shoveling for 82.5 per cent of the time. The remainder of the possible working time, or 17.5 per cent, is spent on other work, the man quitting early for lunch or leaving the mine or commencing to work late at beginning of the shift or after lunch. Observations of this character were gathered by some of the shift bosses, on several hundred-man shifts, and it is surprising how little the figures obtained by each have varied from the average finally obtained.

The average tonnage per hour to be expected of a man throwing the muck a distance of 8 ft. over any period of time is shown in Fig. 1. Experiments to determine the total tonnage shoveled for any period over the same distance showed that for a job lasting 7 hours and [illegible] minutes, with a No. 4 shovel underground, a man would be expected to shovel 26.0 tons a distance of 8 ft. Five representative tests actually gave the following tonnages under average conditions:

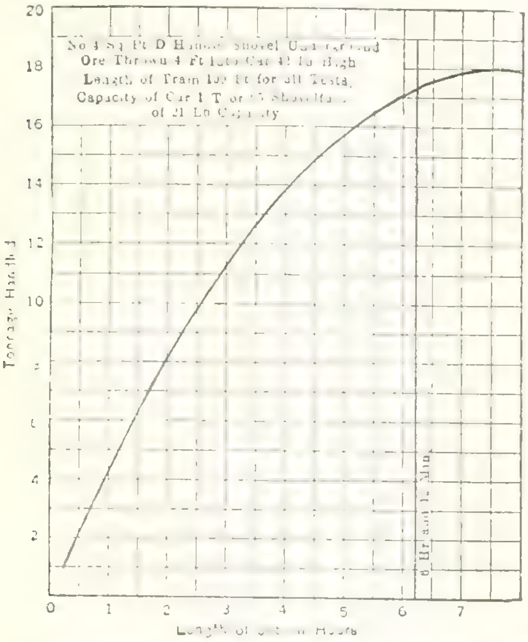


Fig. 4—Capacity of Shoveler Using Car for Various Jobs

	Tonnage
Length of job [illegible] minutes	[illegible]
Length of job [illegible] minutes	[illegible]
Length of job [illegible]	[illegible]
Length of job [illegible] hours and 50 minutes	[illegible]
Length of job [illegible]	[illegible]
Average [illegible] minutes [illegible]	[illegible]

Comparison of Work Done with Scoop and by Shovel. A careful study of Fig. 2 shows the following conditions: (1) The difference in tonnage handled by the same shovel, on the surface and underground, for any length of job, is the measure of the bad effects of underground conditions. For a job of 6 hours and 12 minutes, with a No. 4 shovel, the underground work is 20.5 per cent less than on surface. (2) The difference between the amounts shoveled with the No. 2 scoop and the No. 4 shovel, under same conditions, is the measure of the effect of the difference in load handled by the man. (3) Each line on this chart shows a peak at some particular length of job, and the total tonnage shoveled for any greater period than this is actually less. (4) The presence of this peak accords with the experience of many superintendents and managers, who state that their men do more work in an 8-hour day than they did on the old 10-hour basis. (5) The "economic shoveling day" is about 6⅓ hours, with a No. 2 scoop on the surface, and 5⅓ hours underground. With a No. 4 shovel, on the surface 8 hours is about the proper length of day, whereas underground 6⅔ hours seems to be about correct. As the men actually shovel only 6 1/5 hours per day on an average, and as their other work is generally of a light nature, the 8-hour day with the correctly proportioned shovel is probably the best; but with a scoop it is certainly too long. (6) For work on the surface, on jobs lasting longer than 4⅔ hours, the No. 4 shovel is superior to the scoop. Underground the No. 4 shovel demonstrates its superiority for jobs longer than 3⅔ hours. The scoop thus may be considered as a task shovel for short-time jobs, but even here its value is only slightly greater than the No. 4 shovel and it tires the man so that he is unfit for other work when the shoveling task is finished.

Effect of Height and Length of Throw on Shoveling Speed. The following [illegible] use may be made of the figures presented in the preceding diagrams:

Let W = [illegible];

N = number of shovels per minute;

P = [illegible];

L = [illegible];

T = total tonnage shoveled;

n = number of shovels per minute for an 8-ft. throw;

P = [illegible] lengths of throw.

[illegible]

[illegible]

In using the No. 4 D-handle [illegible] a throw of 3 ft. to the wheelbarrow gave the best results as far as number of shovels per minute and rest periods required were concerned, and in all subsequent work the ore was thrown into the wheelbarrow from this distance. For any length of job, the number of shovels per minute is less than when throwing 8 ft. into a chute, and this is due to the fact that the shoveler must place each shovelful carefully to keep the wheelbarrow from spilling its contents and to make it ride easily.

Figure 3 shows the tonnage to be expected of a man for any length of job, the length of tram being constant at 20 ft. This chart shows that the shoveler has not quite reached his maximum capacity at the end of 8 hours. Two reasons are advanced for this: (1) When [illegible] the ore into a chute, he has a fairly direct throw from the ore pile to the chute, and with a car he has a definite path to traverse each trip. With a wheelbarrow, however, the direction and length of tram are constantly varying, as is also the amount of interference from other trammers, timbermen and machine men. The retarding influence of these factors increases as the length of the tram increases. (2) The sequence of operations, shoveling, tramming, and dumping, is of such short duration and changes so often from one to the other than it is hard to keep up any pace that may be set, and probably an unnecessary amount of rest is indulged in for all periods.

From a series of tests during which the ore was thrown into a mine car 42 in. high, it was determined that a horizontal interspace of 4 ft. was the best distance to maintain between car and ore pile in order that a man might work to the best advantage. Owing to the height of the car, the capacity of a shoveler is decreased, as compared to his capacity in shovels per minute when loading into a wheelbarrow. This decrease in shoveling speed amounts to about 8 per cent per foot of height. The best type of car for a shoveler to use holds about a ton of ore, is as low as is consistent with good design certainly not over 45 in. in height and is equipped with roller bearings, which should be kept in the best of condition. Cars much larger than this are too hard to tram and cars much smaller use up too much of the shoveler's time tramming back and forth.

Tonnage to Be Expected Under Average Shoveling Conditions. [illegible] mucking into a car and tramming a constant distance, for various lengths of jobs. It will be noticed that the economic shoveling day is between 7 and 8 hours long, and that the maximum average results to be expected of a mine shoveler under the given conditions have probably been reached. The tonnage to be expected under average shoveling conditions during a uniform shoveling day of 6 hours and 12 minutes and for any distance that the ore must be thrown or trammed is shown in Fig. 5. The graph representing the tonnage to be expected of a man with a wheelbarrow may not be entirely correct, especially as the length of tram increases. On the other hand, the wheelbarrow is generally used where neither direct shoveling nor the use of a car, with its attendant track expense, is feasible; consequently, the wheelbarrow is always at work under adverse conditions in a stope, and no improvements over the results here tabulated are to be expected.

The calculation of tonnage to be expected when tramming either with a car or wheelbarrow, for any length of job and [illegible]:

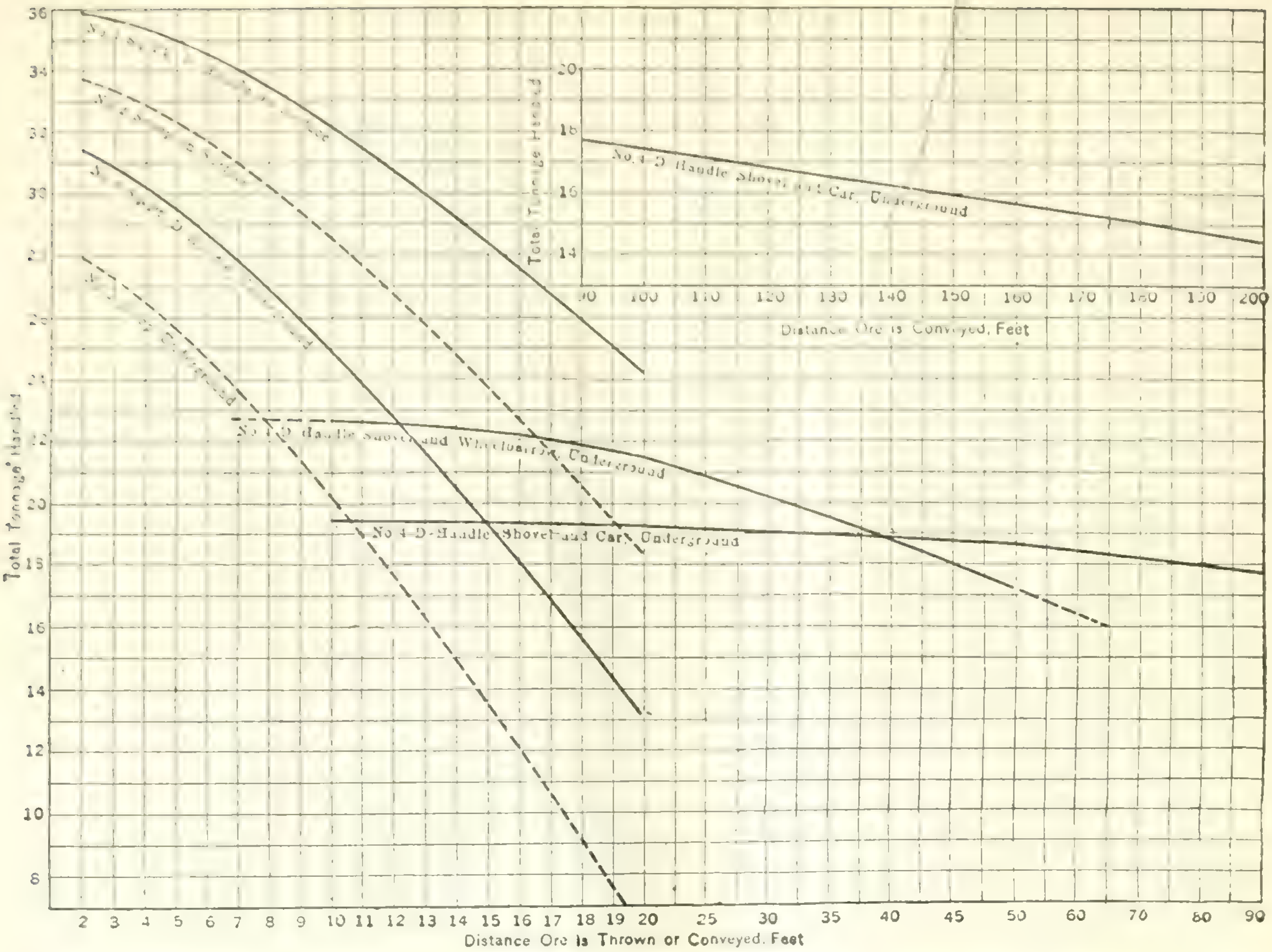


Fig. 5—Comparative Efficiency of Different Methods of Handling Ore in Stopes With Mexican Labor. Length of Job Constant at 6 Hours and 12 Minutes.

Let W = weight of load on shovel, in pounds;
N = number of shovels per minute;
P = per cent of time actually shoveling;
L = length of job, in minutes;
T = total tonnage shoveled;
a = time to load one car or wheelbarrow;
b = time to tram and dump one car or wheelbarrow, in minutes;
c = load on one car or wheelbarrow, in pounds;

$$\frac{c}{W \times N} = s$$

$$\frac{\frac{L}{a + b}\left(s \times c \times P\right)}{2000} = T$$

Effect of Size of Shovel or Scoop on Shoveling Capacity.—To determine the relative wearing qualities and the cost per ton for supplying the men underground with new shovels, different places in the mines were equipped with different makes and styles of shovels, and the results carefully noted. At frequent intervals these shovels were measured to detect the wear of the blade, and checked up to see that all were being used in the proper places underground; the tonnage coming from each place and the number of shovelers employed were also noted.

Tests were conducted with square and round-point shovels varying in size from No. 2 to No. 6 and with standard No. 2 scoops, to determine what size of shovel was best adapted to the work. For short jobs of less than 4 hours' duration, the No. 2 scoop and the No. 5 and 6 shovels were slightly superior from the standpoint of tonnage handled; but for jobs requiring more than 4 hours for their completion, the No. 4 shovel was greatly superior. From the standpoint of "number of shovels per minute," work with a scoop is at all times slower than with a No. 4 shovel, and as the day progresses the percentage of time required for resting becomes greater with the scoop than with the shovel. The result is that although, for short work periods, the larger capacity of the scoop brings the total tonnage handled above that of a No. 4 shovel, for long periods the increased amount of rest required when handling the heavier load serves to put the No. 4 shovel considerably in the lead as a tonnage mover. In general it may be said that for shovels smaller than the 21-lb. load shovel, the tonnage handled per shift is approximately directly proportional to the shovel capacity; that is, if a man using a No. 4 shovel will handle 26 tons in an 8-hour shift, with a No. 3 shovel, which holds 91 per cent of the load of a No. 4 shovel, he would be expected to shovel about 24 tons a shift. If the increased cost of shoveling with a smaller shovel, or one that has been worn, is balanced against the cost per ton of putting a new shovel underground and discharding the old one, it will indicate the economic limit of wear of the shovels in use.

Design of Shovel Best Adapted to Mining Work.—The design of shovel which was considered as being the best adapted to mining work, conforming to conditions under which the tests under review were made, is shown in Fig. 21. The blade should hold 21 lb. of broken ore as an average load. Both the square and the round-point blades should be of standard shape, of No. 15 gage at the point, and of such composition that the shovel will handle not less than 1,100 tons of medium hard ore when shoveled off a wooden mat. All blades should be of the plain-back type without rivets, the back strap being welded to the blade. Only best-grade, second-growth, northern white ash should be used for the handle, which should be bent to the shape and dimensions shown. On short-handle shovels, the Dirigo, or split D, handle is preferred, as it is much stronger than the ordinary D handle.

How to Obtain Greatest Shoveling Efficiency.—To obtain the highest shoveling efficiency underground, every man hired as a shoveler should be in a particular stope or working place that is directly in charge of a shoveling boss. This boss should have had considerable experience in shoveling, should know correct shoveling methods and be able to instruct men and gain their confidence. Each man should be taught: (1) The necessity of using the correct type of shovel for any given purpose; (2) the proper way to handle a shovel; (3) the range of usefulness of wheelbarrow and car, and (4) the advantage of using a platform from which to shovel. When each man has been thoroughly instructed in the methods of shoveling, he should be placed in general run-of-mine work among the more experienced shovelers, so that another new man may take his place for instruction.

Bonus System of Payment of Shovelers.—The Phelps Dodge Corporation has not yet introduced a system of payment for shovel work other than the regular daily wage, and, in the case of development work, the contract system, in which the shovelers share by receiving a higher wage than the men in the stopes. The wage in force at present at Burro Mountain mines for Mexican shovelers is $3.40 a day. Assuming that this is a fair wage for this class of labor, to put the men in the proper frame of mind to take kindly to the bonus system the wage should be raised to $3.75 a day, an increase of 10.3 per cent; this wage will be paid to them whether they make the required tonnage or not. If any man makes the tonnage required of him, his wage may be raised to $4 for that shift, an increase of 17.6 per cent above the $3.40 rate. If he produces anything over the required amount, he should be paid a bonus per ton, depending on the original task allotted to him. To make an increase of 50 per cent over his old $3.40 rate, a shoveler will have to produce between 25 and 30 per cent more than his allotment. Experience has shown that when a laborer receives an advance in wages of more than about 50 to 80 per cent above a fair wage, he tends to become shiftless, and the increase usually does him more harm than good.

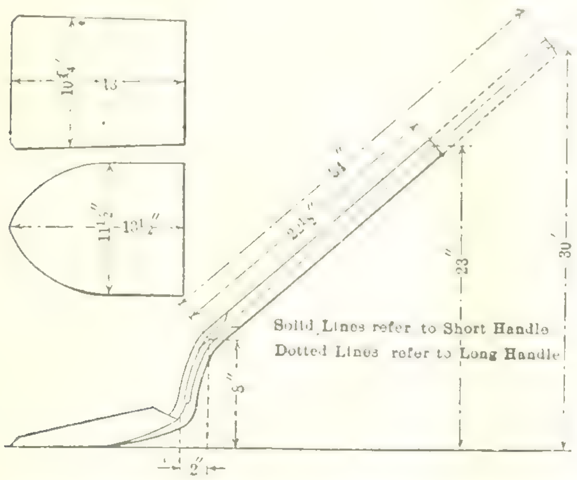

10¾"
13"
11½"
13½"
51"
22½"
23"
30"
5"
2"
Solid Lines refer to Short Handle
Dotted Lines refer to Long Handle

Fig. 6—Design of Shovel Best Adapted to Mining Work

In 1917, in a stope with raises spaced 25 by 65 ft., from which was mined 145,000 tons, the shovelers averaged 8.5 tons per man with wages at $3.40 a day. This shoveling cost 33 ct. per ton, assuming that the men were on other works for 17.5 per cent of the day. Charts show that under the new system these men should have averaged 22.9 tons per day, for which they would have received $4 a day. This would be an average shoveling cost of 17½ ct. per ton or a gross saving of $22,475 for the year. Out of this gross saving would have to come the cost of, say, five special men, at an average salary of $160 a month, or a total of $9,600 a year to take care of this branch of the work. This sum deducted from $22,475 leaves a saving of $12,875, or a total shoveling cost of 23.9 ct. a ton.

Figures obtained at Tyrone indicate that the tonnage in at least one of the large stopes can be raised from 8.5 tons per [illegible] to 22.9 tons per [illegible] of 169 per cent [illegible] wages can be raised from $3.40 a day to $4 a day, and the cost to the company [illegible] ct. a ton, to [illegible] ton, after taking care of all extra supervision needed. In addition to this actual saving in shoveling costs, the overhead and general mining costs will be reduced per ton by mining a greater tonnage per man; and the other classes of labor, such as machine miners and timber men, will be able to do more work, as they will not be hampered and delayed by the shovelers to such an extent as at present.

Fixing Standards for Incentive Wage Plan

Most incentive wage plans are based upon the time required to complete a job. The selection of the fair time, as or it is sometimes called the "standard time," required for an operation involves the making of time studies and careful analyses. Proper rest allowances are made and the logical time allowances for each sub-operation are determined. After these steps have been taken, it is always desirable to classify these figures into a table which may be readily used by a clerk in specifying the correct standard time allowance on current jobs. This problem of the proper classification of basic standard time allowances is a real question with the industrial engineer and is worthy of special discussion. The method of procedure in such a contingency is explained by Mr. A. G. Bryant, Manager Betterment Department, Joseph T. Ryerson & Son, in the 100% Magazine, by means of the following simple example:

[illegible] a time are drawn from the pile by a workman, dragged or skidded through the car door, to be piled on the outside by another man.

We will consider only the handling of the common sizes of southern pine. Let us assume that time studies have been taken with a sufficient number of observations on various sizes of lumber.

[illegible] deduction from [illegible] times have been selected for each individual size. The following are the sizes with the standard time required for each:

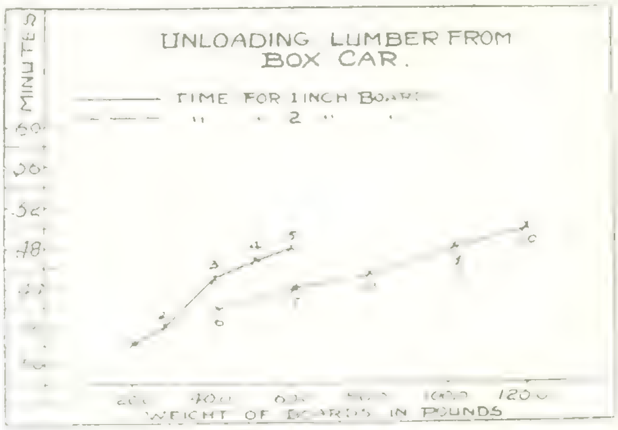
1"x 4"x16' 0"	0.38 min.
[illegible]	[illegible]
1"x 8"x16' 0"	0.45 "
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
2"x12"x16' 0"	0.50 "

The next step is to consider what are the controlling factors, or in other words, the variables.

The weight of the board, of course, affects the amount of energy required to handle it and accordingly varies the time. [illegible] ing factor.

When a thin board bends so that it is clumsy to handle it may require more time and energy than one which, though heavier, is stiffer.

In order to determine the effect of these factors, the stand- [illegible]



[illegible]

[illegible] or board as shown in the foregoing table. The points are located according to a horizontal scale representing the weight of the lumber and a vertical scale representing time in minutes.

A solid line connects the crosses indicating 1-in. boards and a dash line represents the curve of the time for handling 2-in. planks.

A cursory glance alone tells the story of the difficulty in handling thin lumber. It will be noticed that heavier mate-tile actually requires less time than lighter, flexible lumber. It is not desirable to have a separate basic standard for each size of tile and the question now arises as to the method to be followed in classifying.

Although we have no intention of setting up an arbitrary rule, good practice would seem to indicate that the exact standard time as predetermined for any size should not vary more than 10 per cent from the time allowance of the classification arranged to cover it.

Reviewing our chart therefore we see that points 1 and 2 may be classed together but that point 3 cannot be thrown in with them as there is a difference between 2 and 3 of 0.05 minutes or 12.5 per cent. We perceive, however, that points 3, 4 and 5 have a maximum difference of only 0.03 minutes or about 7 per cent and can be grouped together.

Similar reasoning directs us to classify points 6, 7 and 8, and 9 and 10.

We have therefore derived four classifications and by averaging the standards in each one we secure the time to cover the group for practical application.

Efficiency in the Drafting Room*

By WM. P. MUNGER.

The obvious method to follow in overcoming the difficulty of getting enough work through the drafting room to keep the general organization working in balance is to apply the tenets of scientific management to the drafting room management and its production, thereby conserving all the trained help and permitting the immediate and profitable employment of a large percentage of unskilled hands. But managers must remember that scientific management, while it produces marvelous results, must not be pressed on a group of employes faster than they can assimilate it. Failure to observe this has produced results and will again produce results, not marvelous results but violent results such as would be achieved by attempting a 20-mile speed over the unspiked rails of a new railroad.

The preparatary step is to regroup and reroute the work performed, regroup as to the operation through which it passes, rerouting so that each of these operations is performed by the man best equipped for performing the given operation, regrouping so that a high priced man who is capable of laying out work or looking up the related information will not be found part of his time on tracing and other lower grade work, and rerouting so that the larger matters will not come near enough to distract the man of little ability. This change from one man handling the plotting, planning, searching computing and tracing on a whole job will produce the same kind of economy that is apparent on resident construction when a group of handy men are replaced by masons for mason work, carpenters for carpenter work and plumbers for plumbing work.

The second step is that of reordering the department and must be taken before the full benefits of the first step can be realized. There are four positions: chief draftsman, plan master, clerk and checker. The chief draftsman is in general charge, passes on all matters requiring judgment, assigns all work, enforces the use of standard methods, inspects the work for quality and handles all discipline. The plan master receives all work from the chief or the clerk as the work enters the department, looks up all related information and in accordance with his general instruction decides the detail by which the work is to be handled, makes out the proper work card and, from reference to his standard, fixes the time the various operations and parts of the job should take. The clerk has the custody of all information, attends to all filing, issues all supplies, has made and issued all blue prints and attends to all routine matters. The checker inspects all work for accuracy and acts as an understudy for the plan master, just as the plan master does for the chief.

In small rooms the positions can be worked in combinations and in larger rooms these officers will have to have assistants. It has been the custom to relieve an over-burdened chief draftsman by promoting certain deserving young men to the position of assistant chief in charge of this or that or the other thing, a squad boss or special engineer, etc., all of which increase the pay roll, divide the chief's authority and do not and cannot relieve the confusion. So when the number of boards reaches 15 or 20 and the chief cannot further spread himself, care must be taken to make the appointments as instructor or inspector or some such title which does not carry authority with it. I am aware that the placing of the work card by the chief rather than by the plan master is not in accordance with the general shop practice in scientific management, but I think it is best in the drafting-room.

Standardizing the Work.—As the records of the time of drafting increase and the standards are corrected thereby, the standard practice of the room will become what the best man considers a day's work. To speed up beyond this point, to carry the railroad illustration further, better ballasting must be obtained. This is achieved first by trying out the several ways of doing things which are followed by several of the best men, choosing the most desirable, and letting one who can qualify in time and motion study work it up to the one best way, teaching this to all the men and compelling them to do that thing in the one best way. Second, the matter in hand may be analyzed and a standard method and standard time built up from theoretical considerations and the times of the elementary operations. Third, a method radically different may be introduced.

An application of the first method would be to determine whether it is more desirable to turn angles by a protractor or to plot them by tangents, to use railroad curves or a beam compass, to use a parallel rule or triangle.

Having to find the length of property lines crossing concentric right of way lines is a common and tedious problem and can be speeded up by the second method. By taking a little time to work out a formula and scheduling each operation and description of each log in a three-inch column on the left of a sheet of paper, the solution of the problem becomes a simple mechanical matter of filling in a column of numbers on the right. A second problem will be solved by placing a sheet of paper over the first so that the schedule column of the first sheet is exposed to the left of the second sheet. The logs, numbers and angles are fitted in as before and in solving a third problem the sheet many be placed by the side of the schedule to the right of the sheet. Since by experiment we can easily determine that it takes say two minutes to "set up" for solving any proble mand let us say four minutes for taking out two logs, adding or subtracting, and taking out the resulting angle or number, the standard time for solving nearly every problem is readily determinable. This particular application of the second method has the added point that by having the schedule sheet numbered and each man and the checker having a set, much time will be saved in checking.

Introducing New Methods.—But the third method, that of introducing radically different methods, sometimes produced surprising savings in time. In an instance known to the writer the making of several hundred duplicate captions at the rate of three per day was cut to three per minute by the use of a small job press. A boy at one-third the pay did 480 times the work of a skilled draftsman.

In estimating the time required to make a plotting or tracing, the individual length and breadth of each of the various lines are not separately listed but the work is listed in units and then totaled. To ilustrate: In railway work it takes a unit of time to draw a curve, label the P. C. and P. T. and the R. W. lines. A unit of time to draw and label a property line crossing a curve, a unit of time to plat 100 field book entries of culture, and an additional time allowance for each signal made or barn shown, etc. In architectural work, each kind of window elevation would have a unit of time for the first window and additional for each window in the same line.

So the plan master by consulting the list of unit times which apply to the case in hand, can quickly and with a high degree of accuracy determine what is a day's work on a very complicated drawing. In computing it is well to get a rough check on the efficiency of a computer by specifying so many general columns of entries as outlined above for a standard day's work.

General Public Opposed to Government Ownership of Railroads.—Interesting information on the general sentiment regarding Government ownership of the railroads is given by the results of an investigation made recently by the Association of Railway Executives. A questionnaire was sent to the editors of all daily and weekly newspapers in the country, some 13,424 in all. The editors were asked to appraise the sentiment in their communities. Replies were received from nearly 6,000 editors, 83 per cent of whom reported that their communities were in favor of the return of the railroads to private ownership.

Dragline Mounted on Scow for River Channel Excavation

A dragline mounted on a scow is being employed in excavating the channel of the Mad River at Dayton, O., in connection with the flood prevention work of the Miami Conservancy District. The material after being placed on the side of the channel is rehandled into the spoil bank by another dragline. The scow 40 ft. by 80 ft. by 7 ft. in dimensions, has two 12-in. and four 6-in. longitudinal bulkheads extending the entire length of the scow and dividing it into five longitudinal compartments. These bulkheads are built up by 12x12-in. and 6x12-in. timbers, respectively, forming built-up beams 80 ft. long by 6 ft. in depth. These bulkheads are braced longitudinally by 6x6-in. diagonals extending between the floor and deck cross timbers and bolted to the bulkheads. These bulkheads rest upon nine 12x12-in. floor timbers extending from side to side across the scow, with eighteen 6x12-in. intermediate floor timbers spaced between. A similar system of deck timbers is used. These floor and deck timbers are braced by double cross-diagonals 6x6-in. in size. The deck planking is 3x8-in. and the bottom planking 3x12 in. The four spuds are 24x24 in. x 20 ft. They are driven by Wagner alternating current induction motors of 3-phase, 60-cycle type, carrying current at 440 volts, developing 20 HP. at 725 r.p.m. The drive to the spud rack is through three sets of gears and pinions.

The dragline is a Class 175 B Bucyrus, with 3½-cu. yd. bucket and 135-ft. boom. The machine weighs about 200 tons.

The base frame is about 25 ft. square. This base rests on stiffening trusses run lengthways of the scow, the propelling trucks of the dragline being removed. The stiffening trusses are simple triangular (king) trusses, 12 in number, each formed of a 50-ft. 12x16-in. southern pine timber laid lengthwise upon the deck of the scow, with a 2¼-in. tension rod running from the timber ends to the bottom of the scow below the center of the timber, the center post of the truss being formed by timber crib work built between the floor and the deck timbers.

The illustration, reproduced from the Miami Conservancy Bulletin, shows the scow, canted about 6 ft. out of level (by thrusting down on the two right-hand spuds), so that the men on the raft can recalk the joints between the side planking, the tilt being sufficient to raise the lowest joint out of the water. By canting first one way and then the other, both sides were thus recalked.

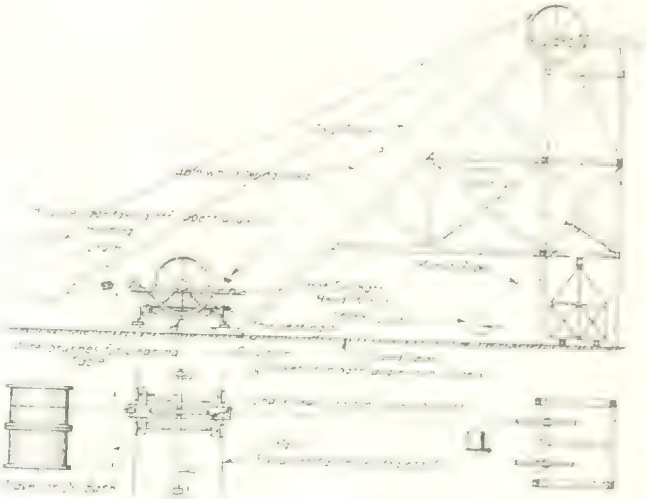
Recalking Joints of Scow.

Device for Oiling Hoisting Cables in Place

An arrangement for oiling hoisting cables without removal from the drum and without causing delay of more than half a shift was described by Mr. Wm. Fleet Robertson in a paper presented at a recent meeting of the Canadian Mining Institute. The arrangement is shown in the accompanying sketch. It can be cheaply constructed from materials already around most mines, and it accomplishes the oiling at a nominal expense. The method of oiling is as follows:

The cage is brought to the surface, and there blocked on timbers; the cable is detached from the cage and attached to a manila tail rope. The cable is then wound up on the hoisting-drum until the end of the cable and tail rope come to the oil-bath. The end of the cable is then detached and passed through the bath and under the sheave wheel; it is then attached again to the tail-rope by which, with the aid of a hand-winch, the cable is slowly pulled through the heated oil-bath and back to the cage, where it is re-attached and the empty cage slowly lowered to the bottom. The operation is then reversed [illegible] the cable.

About 16 ft. of the cable would be in the bath at one time and if the cable is passed through at a rate of 4 ft. per minute it would be given an immersion of 4 minutes, which should be sufficient. The oil in the bath ought to be kept at a temperature of over 212° F. by the aid of live steam pipes and it is suggested that vaseline with flake graphite mixed through it will probably be found to be the most effective and lasting.



Arrangement for Oiling Hoisting Cable Without Removing It From the Drum.

It is essential that the cable before entering the bath should be as thoroughly cleaned as possible of all dirt by the use of wire brushes. The horizontal travel of the cable in unwinding will automatically move the bath and carriage on rails and so keep it in line at all times.

The supporting shaft of the bath sheave wheel must be anchored down sufficiently to hold the upward pull of the cable after the cage is attached.

Removing 11 Ft. Diameter Tree with Dynamite

A chestnut tree, 34½ ft. in circumference, 70 ft. high, and nearly 11 ft. in diameter just above the ground was blasted down with dynamite. The tree was located near Quakertown Pa., and had been killed by blight 2 years ago. The method of dynamiting was as follows:

Four bore holes were put down at an angle to a depth of eight feet under the center of the trunk. These were loaded with small charges of dynamite and shot, the object being to form cavities in the earth into which the large charges which it was estimated would be necessary to blast out the tree could be loaded. About a dozen holes were then bored into the large roots at a considerable distance from the trunk and charges loaded into those holes large enough to cut the roots and permit the lifting charge under the trunk to do its work effectually. A Schramm pneumatic boring machine was used to bore the holes. Each of the four holes under the trunk were loaded with 25 lbs. of 20 per cent ammonia dynamite. A ½-lb. charge was used in each of the holes in the roots. No. 6 electric blasting caps were inserted in all the charges and the various charges were connected together in series and fired electrically with a blasting machine. The shot was a perfect success. The tree was lifted up a few feet and dropped over on its side. All roots were taken out or cut off well below plow depth and in addition, the tree was broken up so that the pieces could be handled and hauled away. The blast made a crater in the earth about 12 ft. deep and 30 ft. in diameter.

Pedestal Track Construction

As is well known, the use of substitutes for wooden ties has been of relatively greater importance in foreign countries than in the United States and for reasons equally well known. These substitutes have replaced the wooden tie with various forms of steel and of reinforced concrete, and have also in some cases done away with the tie altogether and supported the rail on either a longitudinal support or on reinforced concrete pedestals, with tie bars to maintain the gage.

In the Railway Maintenance Engineer reference is made to experiments in progress on the Shalimar branch of the East Indian Ry. with the pedestal type of construction. A Government inspector at Calcutta reported that installations of these ties (or substitutes) were standing up well after several years' service and were a promising feature of track construction.

Another slightly different form of construction is referred to in the same journal as having been experimented with in Holland. This consists of concrete pedestals under the rails supporting steel ties of channel section. The concrete is protected from the shocks of the traffic by two hardwood wedges with an inclination of 1 in 10, placed between the pedestal and the ties. The pedestals and the ties are spaced 4 ft. apart, except at the joints where a 2-ft. spacing is used. Mr. K. den Tex of Utrecht, Netherlands, in writing of this type of track support, gives his experience with several varieties, in the attempts made to obtain a lighter pedestal and a simpler mode of attachment. His conclusion is that for these several types of pedestal construction, the only work of maintenance which has proved necessary has been surfacing. The track needs some attention in the beginning, but the gravel under the pedestals is soon packed to the point where it gives an excellent support, owing to the large base. The rail-surface can be regulated by loosening the bolts and arranging the wedge, or by lifting the track with the jack and shoving some gravel under the pedestals. Both ways are easy compared with the tamping of ordinary ties.

News Letter

St. Louis Items

A. W[illegible] moved his outfit to [illegible], Iowa. Reports lots of [illegible] but not much progress.

The Board of Public Service, St. Louis, Mo., will receive bids for the improvement of a number of alleys on June 24.

M. M[illegible] Contracting Co. are working a team outfit on Dunn & Mc[illegible]'s grading job in northern part of the city.

Columbus S. [illegible] started work on several new bank widening jobs on the Rock Island R. R. in Iowa and Northern Illinois.

W. P. McGeorge & Co. moved their team outfit to Morrillton, Ark. Report a shortage of teamsters in their neighborhood.

The Frazier-Davis Construction Co., 322 Wright building, St. Louis, Mo., got in on a piece of the Springfield-Peoria highway.

J. C. Kaiser and A. Mangold have made a good start on grading the grounds for the Southern Wheel Co.'s new plant here.

Lee J. Beatty expects to finish his job at Columbus, O., in a couple of weeks. Wants another job that will suit a 25-team outfit.

Lee Hale was awarded some street work in Arkansas City, Kans. Lee says this will hold him until some good railroad work opens up.

D. C. Gahan was awarded the contract for building a levee around St. John's Hospital, Springfield, Ill. About 40,000 yards in this job.

R. T. Amis secured a nice grading job at Guthrie, Okla., building a big reservoir for the Missouri, Kansas & Texas R. R. Subbed this from Cook & O'Brien.

Contractors when in want of labor or work for their outfits write Koenig's Labor Agency, 612 Walnut street, St. Louis, Mo., or 503 Delaware street, Kansas City, Mo.

Tom Walsh and Dan Terry of the Walsh Construction Co. passed through St. Louis the other day on their way to Omaha, Ark., where they are finishing a Missouri Pacific R. R. contract.

Rain and nothing but rain the past month has delayed all grading work in this part of the country. Several jobs that could have been completed in three or four days a month ago at this writing are still uncompleted.

Bates & Rogers Construction Co. were awarded in the neighborhood of $1,500,000 worth of work on the new Springfield & Peoria hard road highway. They have opened an office in Mason City, Ill. F. E. [illegible] is in charge.

The Scullin Steel Co. let the contract for the immediate construction of a $2,000,000 steel rolling mill with a capacity of 10,000 tons of finished material per month. It is planned to have it ready for operation by the first of next February.

P. L. Hoskins of the C. R. Cummins Co. came to town one day last week when the writer was out fishing. Sorry we missed you this time, Hoskins. In future give us a tip when you expect to be here and we will manage to try and postpone the fishing trip.

J. W. McMurray of Kansas City returned from Little Rock [illegible] May. [illegible] while there his friend E[illegible] Farrell wanted to know if he had any "wild cow's milk" in his room. We've heard it called everything but "wild cow's milk." Wonder what [illegible] will call it after July 1.

The National Construction Co., 302 Putnam building, Davenport, Iowa, secured the contract at E[illegible], Iowa, for the construction of approximately five miles of storm drain. The digging will practically all be done by machine with the exception of some light work on connections about 3 to 5 feet deep.

Wm. J. Dankiel of Mt. Olive, Ill., has taken a slice of Bates & Rogers' new hard road work near Mason City, Ill.

The Moreno-Burkham Construction Co. of St. Louis was awarded a contract at Edwardsville, Ill., by the Madison County Board of Supervisors for the construction of five miles of monolithic brick paving on the St. Louis-Alton road. The bid is $169,307. The highways will be paid for from a bond issue of $600,000 voted by Madison County and the sum spent for the road will be returned when the Illinois State Highway Commission takes over the road.

Wm. List informs us that he is interested in thirteen different contracts at the present time, among which are reservoirs at Abilene, Stanford, Ranger and Enthridge, Tex.; a shovel job at Alexandria, La., for the T. P. R. R.; also a big grading job for the Dallas Board of Trade at Dallas, Tex. They have opened a new office in the West Texas Bank building at Dallas, Tex. Better get a new job, Bill, and make it fourteen.

List & Hallett Construction Co. got in on a nice new rock job on the I. C. R. R. at Golconda, Ill. J. J. Hallett, vice president of this company, informed the writer that the List companies were awarded 60,000 yards of rock work on the Fort to Fort Highway at Lawrence, Kan., passing Jess Willard the champion prize fighter's farm. Hallett is going to take boxing lessons from the champion during his stay out there, so don't get gay with Hallett in the future.

A. B. KOENIG.

Personals

William L. Lanard has been appointed assistant engineer in the Department of City Transit of Philadelphia, Pa.

W. H. Tippin has been appointed general manager of the Southern Dry Dock & Shipbuilding Co. at Orange, Tex.

Maj. Earl R. Stewart of Grand Rapids, Mich., has been appointed a member of the State Public Utilities Commission of Michigan.

Lieut. Ralph K. Linville has been made a captain and put in charge of camp engineering at Eustis, Va. He formerly was an assistant water engineer at Lake Montebelle and Loch Ravan, Baltimore, Md.

J. Vibord Davies, Col. William J. Wilgus, Maj. Charles A. Bensel, Col. Henry W. Hodge, William H. Burr and Edward J. Byrne have been selected as consulting engineers by the New York and New Jersey Tunnel Commission for the proposed $15,000,000 vehicular tunnel between New York and New Jersey. Clifford M. Holland has been appointed chief engineer of the Commission.

George H. Webb, colonel of the 16th Engineers, has resumed his former duties as chief engineer of the Michigan Central, the Chicago, Kalamazoo & Saginaw and the Detroit Terminal, with headquarters at Detroit. J. F. Biemling, acting chief engineer of these roads, has resumed his former duties as assistant chief engineer, with headquarters at Detroit, to succeed George H. Harris, who has been performing the duties of assistant chief engineer, and [illegible] assume the duties of special engineer on these roads.

W. E. Hart has been appointed district engineer in charge of the Minneapolis office of the Portland Cement Association. This office, which is located in the Metropolitan Bank building, has charge of association work in Minnesota, North and South Dakota. Mr. Hart has been connected with the Portland Cement Association for the past two years and has been engaged principally in South Dakota. Prior to joining the association he was county engineer of Eddy County, North Dakota, and city engineer of New Rockford, N. Dak.

Obituaries

John F. Quinters, a railroad contractor, died June 7 at Shontsville, N. Y., aged 86. He followed the occupation of timber contractor for mines for 28 years, when he entered railroad construction work, which he followed 26 years, when he retired.

Benjamin F. Slaw, a retired engineer and superintendent of the Wayne estate, died June 4 at Wayne, Pa. He was 83 years old. Mr. Slaw was an engineer at the Philadelphia water works and for 35 years was superintendent of the water works at New Castle, Del.

John A. Kelley, of Ryan & Kelley, railroad contractors, Philadelphia, died May 30 at his home in that city, aged 72. He built many important works for the Pennsylvania R. R., among them being a portion of the Schuylkill Valley R. R., including the Phoenixville tunnel.

Industrial Notes

The Sullivan Machinery Co. has established a new branch office at Room 810, Park building, Cleveland, O., under the management of Ralph T. Stone, for several years past sales engineer associated with the New York office of this company.

H. L. Garbutt, for the last six years manager of the line material section of the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., has been appointed manager of the supply division of the Westinghouse San Francisco office.

The Portland Cement Association announces the opening of a district office in Los Angeles, Cal., in the Merchants' National Bank building. This office will be in charge of association activities in Southern California and Arizona. H. H. Fillmore is district engineer in charge.

The Sullivan Machinery Co. has appointed George H. Richey as New England sales manager to succeed George Elmer Wolcott, who died May 10, 1919. Mr. Richey has been associated with Mr. Wolcott as sales engineer in New England and Eastern Canada for several years past. The Boston offices remain at 201 Devonshire street as heretofore.

Vernon T. Brauns has assumed the management of the American Blue Print Paper Co., Chicago. In the summer of 1919 Mr. Brauns was in the government service at Camp Custer as a civilian employe, but upon his release from service he returned to the American Blue Print Paper Co. and has since been devoting his energies to efficiency and production development and to the outlining of sales promotion.

Sauerman Bros., Monadnock block, Chicago, Ill., announce the return of Maj. D. D. Guilfoil to his old position as sales engineer. Maj. Guilfoil commanded the 1st Battalion of the 108th Regiment of Engineers. This regiment, which was composed almost entirely of Chicago men, participated in two major operations in France, the Somme and Meuse-Argonne offensives. Maj. Guilfoil received his discharge at Camp Grant on June 7 and resumed his old job on June 9.

Building and Structural Monthly Issue

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The *articles* in the first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering and contracting field. The *articles* in the first and last issues of each month (1st and 4th Wednesdays) completely cover county engineering and highway engineering and contracting. The *articles* in the third and last issues of each month (3rd and 4th Wednesdays) completely cover steam and electric railway location, design and construction. See the "mast head" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation and Dredging (c) Quarrying [illegible]
(b) Rivers and Canals (d) Railways, Steam and Electric
(e) Management and Office System

Buildings and Structures—4th Wednesday
(a) Buildings (c) Harbor Structures
(b) Bridges (d) Miscellaneous Structures
(e) Properties of Materials

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Are "Trades" Evolving Into "Professions"

Due to the fact that few men have studied logic, not many of us habitually define the words that we use. Indeed it is customary to regard all the words in common use as being so well understood as to need no formal definition. This careless attitude toward language is not only the cause of countless errors in reasoning, but of numberless controversies that lead to no conclusion.

In a recent address by Dr. C. Stuart Gager, of the Brooklyn Botanic Garden, an attempt was made to show that horticulture is a "profession" and that gardening is a "trade." Yet specific definition of "profession" and "trade" were not given. Dr. Gager did undertake, however, to indicate the main points of difference between a profession and a trade. These differences, according to him, are substantially as follows:

1. A trade may be learned solely by one's own experience, whereas a profession can be learned only by adding to one's personal experience the experience of others.

2. A trade is learned by serving an apprenticeship, acting by "rule of thumb"; whereas, a profession is learned from teachers, who impart a knowledge of principles and theories.

3. A trade involves only the skillful application of practical rules; whereas a profession involves an understanding of the reasons upon which such rules are based, that is a knowledge o[illegible]

Dr. Gager said: [illegible]

Horticulture [illegible] certain sciences; a knowledge of those fundamental sciences is necessary—soil technology, economic entomology, the elements of botany, with special emphasis on plant physiology; something of plant pathology, the principles of plant-breeding, ecology or the relation of plants to their environment; something of physics and chemistry, plant geography, and the history of cultivated plants. Moreover, one should know the history of his profession, be acquainted with the classic publications, the names and lives of the founders and leading horticulturists. One can never keep abreast of the [illegible] in [illegible] with the new and [illegible] literature of [illegible] horticulturists is stimulating, if not essential."

These [illegible] tion of the meaning of [illegible] terms before reading [illegible] compare our definitions with ou[illegible] and with those [illegible] tion, learned in part by [illegible] experience, but mainly by prolonged systematic study of the experiences

28 Pages = 40 pages

The 28 pages of articles in Engineering and Contracting contain as many words as 40 pages of the size and typography commonly used by other engineering periodicals. Ours is the same size of type and type-page as that of The Literary Digest—easily read, yet giving a large volume of reading matter per page. Our 28 pages of articles would fill 112 pages of the standard 6x9 in. text-book. It would take 10 such books of 580 pages each to hold all the articles printed each year in Engineering and Contracting, to say nothing of our weekly construction news.

and theories of other men.

A trade is an income-producing occupation learned in part by personal practice and experience, and in part by apprenticeship, but without prolonged systematic study of the experiences and theories of other men.

If these definitions are acceptable, it follows that a trade may merge into a profession. It also follows that a trade may rise to the rank of a profession. In its early history, engineering was more of a trade than a profession. Gardening is a trade, for most men that practice it, but for a few it is a profession, and they call it horticulture. In the course of a generation it may happen that nearly all managerial gardeners in America will be trained horticulturists.

Are we not, in fact, entering upon an age of evolution of trades into professions? Certainly the astonishing increase in trade books, and class periodicals, and technical courses, indicates a rapidly growing tendency to study systematically and continuously the experiences and theories of other men. And when the majority of men in any "trade" have become habitual students of their "business," then that "trade" may claim to have risen to the rank of a "profession."

Is the Beauty of the Pantheon Superior to the Utility of the Brooklyn Bridge?

In a recent editorial the "Building Review" argues that "the special sphere of the architect is the sphere of planning," and that in this sphere "he can never be approached by men who are untrained in the problems that good planning involves." To quote further:

"We see here a better common ground for engineer and architect to meet upon than any other, and from such an understanding of each other's value there can develop nothing but mutual good to each profession, the furtherance of engineering, and the employment by architects of their special ability upon works that at first glance seem foreign to architecture but which in the light here shown proves itself to be simply a proper extension of the architect's work and a legitimate use of the architect by the engineer; just as the architect calls in the engineer to solve his own—the architect's—structural and mechanical problems.

"The engineer is indispensable to the architect as a specialist in a field which the architect sensibly realizes is not his own except indirectly, and no less is the architect indispensable to the engineer in a field that, likewise, the engineer should realize is not his own except indirectly—the field of planning."

We are at a loss to understand this statement, unless it implies that engineers are merely detailers and not "planners." We had thought that engineers were trained to plan, particular emphasis being placed on economic planning. We had thought that architects were also trained to plan, particular emphasis being placed on artistic planning. It had never occurred to us that anyone would claim the entire "sphere of planning" as being identical with the sphere of architecture.

But before we get deep into controversy, just what is meant by the word "planning"? Does it not signify designing something to accomplish a given purpose? Luther Burbank plans the plant that he wants to produce. He draws a mental picture of it and he specifies its properties in detail. Then he proceeds to produce the plant that he has planned. Should he consult an architect before trying to plan a fruit or a flower? Civil engineers plan bridges, railways, buildings, what not. Should they invariably consult architects before doing so? It is true that engineers frequently do, and more frequently should, consult architects in order to improve the artistic appearance of bridges and buildings. But to admit this is quite different from conceding that only architects are "trained in the problems that good planning involves."

By all means let us have co-operation between architects and engineers in planning buildings and bridges, but let neither profession look upon itself as superior to the other. How illogical it really is to compare incommensurables. Esthetics and economics are incommensurable. Is the beauty of a Burbank rose superior to Edison's incandescent lamp? Is the glory of the Pantheon superior to the utility of the Brooklyn bridge? Is an architectural beauty superior to an engineering economy? The questions are absurd, and so is the contention that the architect is superior to the engineer or the engineer to the architect, each is his special field.

A Remarkable Invention by the Engineers of the Forestry Department

The Forestry Department has invented a remarkable waterproof glue with which built-up beams of wood can be made that are stronger than solid beams. If the cost of such built-up timbers is low enough, structural engineers will have to revise some of their ideas as to the economic value of wood.

Since small sticks can now be glued together to form as large sticks as may be required, it follows that trees can be cut before maturity. This alone should result in greatly decreasing the cost of producing lumber, for trees, like animals, grow fastest when they are infants.

There are countless acres of logged-off hills that are of no use agriculturally and probably never will be. If these hills are reforested, and if valuable timber can be harvested every ten years, there will surely be reason to regard lumber as a product in no danger of ever ceasing to be used because of high cost.

In this connection we may call attention to Luther Burbank's remarkable achievement in accelerating the maturing of walnut trees. With men such as Burbank showing us how to make trees grow several times faster than normal, and with inventors showing us how to build large timbers from small trees by the use of glue, it may come about that lumber will be used more extensively in the future than it ever has been used in the past.

If as much brains and capital should be devoted to the solution of problems in timber economics as to similar problems in steel and concrete economics, it might readily happen not only that our "vanishing forests" would cease to vanish, but that our vanished forests would appear again on a million hills. Stranger things are happening in this age of miracles.

The Economic Fallacy of the "Back to the Farm" Slogan

For a generation Americans have been repeatedly told that the growth of urban population at the expense of the country population is deplorable. We have so long and so frequently heard the wailings of editors and "economists" on this topic that most of us have doubtless come to agree with them in believing that moral and economic decadence will occur unless the exodus from farms to cities can be curtailed. How many of us have gone so far as to ask for proof of the contention that the abnormal growth of our cities is really so objectionable as it is pictured?

The underlying reason for the exodus from our farms is simply this. There is a relatively limited demand for food products, but there is an almost limitless demand for expensive clothing, housing, amusements and luxuries. Given a relatively limited demand for foods, coupled with a never-ending increase in labor-saving machinery for farm use, it necessarily must follow that progressively fewer men will be required on the farms. As labor-saving machinery frees workmen from the fields, they are attracted to the factories for the demand for expensive textiles, etc., increases as general wealth increases.

In Russia and other primitive countries where machinery has not yet freed many agricultural toilers, a very large percentage of the population remains rural. But is the population of such countries more healthy, prosperous or happy than in countries like England? Statistics answer "No" as to the health and prosperity. Since there are no statistics as to happiness, we can only infer that a negative reply would be had as to that factor, since happiness usually follows in larger measure where healthfulness and prosperity are greatest.

Because of the unusual prosperity of our farmers it will not be surprising if so much capital is attracted into the farming business as to result in an overproduction of foodstuffs within the next few years. Tending toward this result is the progressive lowering of interest rates on farm mortgages, a tendency that has been increased by the Government's paternalistic policy of making long-time low-rate loans to farmers.

American inventors, engineers and managers have steadily increased the productivity of workers in every line of activity. As the market in any given line approaches saturation it often happens that advertising and education serve to increase the demand in that line, thus moving the saturation point farther away into the future. But since the average vigorous man can eat only four pounds of food daily, no amount of advertising or education will result in adding to his daily demand for calories of food energy. All that can be done in that line is to shift the demand from one sort of food to another. It is possible, of course, to shift the demand from grains, fruits and vegetables to meats, and thus increase the number of workers needed on the farms to supply the demand. Similar changes in demand for more expensive foods may tend temporarily to curtail or even stop the exodus from the farm, but eventually the exodus will be resumed, because the demand for foods is relatively limited as compared with the demand for other products.

Three Opinions of Three Leading Americans as to the Persistence of High Prices

The heads of large industrial and public utility companies have been slow to express opinions as to the probable course of prices. But within the past few weeks such men have been voicing the belief that high prices will persist indefinitely.

Julius Rosenwald, head of the great Chicago mail order house, Sears, Roebuck & Co.; J. Ogden Armour, head of the packing firm that bears his name, and Theodore N. Vail, president of the American Telegraph and Telephone Co. (the Bell System), form a triumvirate whose opinions will carry great weight. We quote from recent utterances by these three leaders.

Mr. Rosenwald said:

"It is my belief that the range of prices for the necessities of life will average little, if any, lower than at the present time. Though there will be some exceptions, I do not look for a sudden or violent reduction of prices in the near future aside from those which have been artificially stimulated."

J. Ogden Armour makes the following somewhat similar statement:

"The greatest danger to our economic structure today arises from the failure of many to recognize a new and higher level of prices, based on permanently increased cost of labor, and high taxation. Those who postpone building or buying in the hope of materially lower prices are speculating in the future misfortune of the nation."

And this word comes from Theodore N. Vail of the American Telegraph and Telephone company:

"A favorable factor to big construction is the present tremendous latest demand for buildings, commodities, labor and raw material, which is expected to bring on a period of intense activity and national prosperity. It is also well to consider that, excepting steel, the rise in the cost of building materials has been relatively small as compared with other commodities. The price of lumber in particular may easily go higher, and in view of the decreasing lumber supply may never get back to the low levels of 1913-14."

That retail prices for food reached their peak in December, 1918, is one of the results of the recent investigations made by the Bureau of Labor statistics. There were slight declines in January and February, but advances the next two months. In April, 1919, the cost of twenty-two articles of food combined was for the United States as a whole 18 per cent higher than in April, 1918, and 85 per cent higher than in April, 1913.

E. & C. Index Furnished Only on Request

Previous to last year [illegible] been our custom [illegible] the index of our articles to all subscribers. In common with many other publishers we now have adopted the practice of sending the index to only such subscribers as request it. Therefore, if you want the index for the 6 months ending June 30 you should notify us at once. Those who requested the index for the previous volume have been listed and need not notify us again.

Wage Increases of Railway Employees

To the Editor:

Referring to article in the May 28 issue of Engineering and Contracting entitled "The Past and Prospective Rise of Wages in the Building Trades": It is stated in the second paragraph on page 162 that "the U. S. Government has raised the wages of the average railway employe 84 per cent."

It may be that the writer of this article can produce the necessary statistics to prove this assertion, but I do not believe he can find a member of the engineering department of any railroad holding the same position he held on Dec. 27, 1917, whose salary has been increased 84 per cent.

I also do not believe that sufficient increases were granted in other departments to raise the average to 84 per cent.

I would suggest that some authentic figures showing the actual increases in salaries received by railroad employes in all departments since Dec. 27, 1917, be published in an early issue of Engineering and Contracting.

A. F. WETMORE, Engineer.

Omaha, Neb.

[We thank Mr. Wetmore for calling attention to the error relative to the increase in railway wages. According to the I. C. C. report for the year ending June 30, 1916, the railways paid about $1,400,000,000 to 1,640,000 employes during that year. In the fall of 1916 the first great increase in railway wage rates was made. Exact figures as to the total increases are not to be had. The Railway Age estimates that the year 1919 will show a wage increase of about $800,000,000, as compared with the pre-war wage total. This is equivalent to about 57 per cent increase over the wages paid in 1916; but there has also been an increase in the number of employes. It will be noted that the 1,640,000 employes in 1916 received slightly less than $900 each. It has been stated that the average pay now is about $1,460. This would indicate an increase of 62 per cent in the average wage rate of railway employes.—Editor.]

Effect of Time of Cutting Timber on Its Durability

Many of the theories which have been advanced regarding the durability of wood attribute too much importance to the time of cutting. As a matter of fact, the time of cutting has very little effect upon the durability or other properties if the timber is properly cared for after it is cut. The method of handling posts, poles and logs at different times of the year, however, does influence their durability.

Posts, poles, and other rough products cut in late spring and early summer are more likely to be attacked by insects and fungi because the wood is freshly cut and in the most favorable condition for attack at a time when insects and the spores of fungi are most active. Seasoning also proceeds more rapidly [illegible] and piled openly on skids for seasoning the opportunity for decay will be reduced to a minimum, but checking will not be retarded. In no case should the wood be allowed to lie in direct contact with the ground. If checking is an important consideration it can be reduced somewhat by locating the piles in a shaded but dry place. The bark peels most [illegible] time of the year but the labor and expense will probably be greater.

[illegible] and when proper storage or handling is impracticable, winter cutting is best. Fungi and insects do not attack wood out of doors in cold weather and by the time warm weather arrives the wood is partly seasoned and somewhat less susceptible to attack. It is [illegible] winter cutting is advantageous and not on account of a smaller amount of moisture or sap in the wood in winter as the popular belief has it. There is practically no difference in moisture content of green wood in winter and summer.

Formula and Table of Weights Steel Roof Trusses

BY MARSHALL L. MURRAY

[illegible]

Several years ago the writer had occasion to prepare some designs for steel roof trusses for preliminary estimates for factory buildings. After several designs had been prepared and lists of material and estimates of cost had been made, the data on hand were used in several formulas for giving the weights of steel-roof trusses, in order to find one which would give results closely agreeing with the figured weights. If such a formula could be found it was intended to use it for purposes of preliminary estimates instead of taking time in preparing a design. But no one formula gave results which were considered satisfactory. It was observed that the Ricker formula

$$w = \left(\frac{S}{25} + \frac{S^2}{6000}\right) S A$$

gave results which were too low and the Ketchum formula,

$$w = \frac{P}{45}\left(1 + \frac{S}{5\sqrt{A}}\right) S A$$

gave results too high to agree closely with our design data. In these formulas w equals total weight of truss; S equals span of truss in feet; A equals distance center to center of trusses in feet; P equals carrying capacity of truss in pounds per square foot of horizontal projection of roof.

After carefully studying the formulas and reading the explanation of the Ricker formula in University of Illinois Bulletin No. 16, and that of the Ketchum formula in the author's text book on Steel Mill Buildings, it occurred to the writer to combine the two formulas, thereby making use of the span factors in the Ricker formula and the center to center of truss factor and the variable load factor in the Ketchum formula. From the bulletin it seemed the carrying capacity of the trusses upon which the Ricker formula was based was about 50. Therefore the results obtained by using the data on hand with the Ricker formula were increased in the ratio of $\frac{P}{50}$, since the Ricker formula does not take into account the variable load P. These weights were then averaged with those obtained by the Ketchum formula, which considers the variable load P, and the final results agreed quite closely with the data on hand. The tentative formula then became

$$w = \left[\frac{\frac{P}{50}\left(\frac{S}{25} + \frac{S^2}{6000}\right) + \frac{P}{45}\left(1 + \frac{S}{5\sqrt{A}}\right)}{2}\right] S A$$

From trial calculations, the two factors $\frac{P}{50}$ and $\frac{P}{45}$ were averaged and made the same for both formulas. Then

$$w = \frac{1}{2} \cdot \frac{P}{47.5}\left(1 + \frac{S}{25} + \frac{S^2}{6000} + \frac{S}{5\sqrt{A}}\right) S A$$

After several trials with the slide rule the variable load factor was made $\frac{P}{42}$ instead of $\frac{P}{2 \times 47.5}$ or $\frac{P}{95}$, so as to agree with the figured weights. Therefore the formula finally derived was

$$w = \frac{P}{42}\left(1 + \frac{S}{25} + \frac{S^2}{6000} + \frac{S}{5\sqrt{A}}\right) S A.$$

In order to try out the above formula it was applied to all trusses upon which we had the necessary data, and to others used as examples in text books and the results were remarkably close to the weights obtained from material lists. After finding that the formula was worth while the writer prepared the accompanying table to simplify its use. This was done by making P equal to unity and calculating the value of w for a number of values given to S and A. It will be noted this reduced to a simple multiplication the calculation necessary to find the weight of a steel roof truss, having given the span, distance center to center of trusses, and the carrying capacity of truss. The writer has found this table to be very useful and quite reliable in preparing preliminary estimates, and even as a check on weights figured from a design.

WEIGHTS OF STEEL ROOF TRUSSES

[illegible] weight of truss for a capacity of 1 lb. To find total weight [illegible] multiply value in table by capacity of truss, P.

Span of truss in feet: Out to out of bearings = S.

A	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	110	120
[illegible]	[illegible]	6.8	[illegible]	12.5															
[illegible]	[illegible]	8.4	11.7	15.5	19.8	24.7	[illegible]												
[illegible]	[illegible]	[illegible]	[illegible]	18.3	23.5	[illegible]	35.8	42.9	[illegible]	59.4									
[illegible]			16.0	21.1	27.0	33.6	41.1	49.3	58.4	68.3	[illegible]	90.5							
[illegible]				23.8	[illegible]	[illegible]	[illegible]	55.6	65.8	[illegible]	[illegible]	102.0	116.0	131.3					
[illegible]					[illegible]	42.1	51.4	61.7	73.0	[illegible]	98.8	113.2	128.9	145.7	163.6	182.6	[illegible]		
[illegible]						46.3	55.4	67.7	80.1	[illegible]	108.5	124.1	141.4	160.2	[illegible]	[illegible]	222.5	271.1	
[illegible]							61.4	73.6	87.1	101.9	117.9	135.0	[illegible]	173.7	195.3	218.1	242.1	295.0	353.8
[illegible]								[illegible]	[illegible]	110.0	127.2	145.7	166.0	187.6	210.7	235.1	261.4	318.5	382.0
[illegible]										[illegible]	[illegible]	156.1	178.0	201.1	226.2	252.2	280.3	341.6	409.5
[illegible]												166.9	189.9	214.6	241.1	[illegible]	299.8	364.7	437.7
[illegible]														228.5	256.0	[illegible]	317.8	387.2	[illegible]
[illegible]															271.1	302.7	336.3	410.2	492.1

For general purposes P = 40 lb.

Distance c. to c. of trusses in feet = A.

Economies of Using Portland Cement in Bulk

A cement products manufacturer having a total consumption of about [illegible] bbl. of cement per year effected a saving of $96 per day by using bulk cement, according to a paper presented before the Western Society of Engineers, by Wallace R. Harris, Engineer, Cement Products Bureau, Portland Cement Association. The saving effected by using 500 bbl. builk cement per day was itemized as follows by Mr. Harris:

Difference in price, 500 bbl. ....at	$0.05	$25.00
Labor saved in unloading 500 bbl. ....at	.03	15.00
Saving in cement returned with bags, 3.5 bbl..at	2.00	7.00
Freight and labor saved on 2,000 M. T. sacks...at	.01	20.00
Saving in lost and damaged sacks, 5 per cent..at	.25	25.00
Interest saved at 6 per cent on money invested in sacks, estimating that sacks are returned each month		2.50
Saving in [illegible] insurance on labor used in handling sacked cement and M. T.'s at 5 per cent		1.75
Total saving on 500 bbl. ....at	19¼	$96.25
Saving for 300 days per year at $96.25		$28,875
This saving is equal to 6 per cent interest on an investment of		$481,250.00

Savings on the following items have not been included in the tabulation above: Fire insurance rates on empty sacks in storage or in transit and the rental value of storage space occupied by empty sacks and the rental value of the greater space required for storage cement in packages.

The above saving of $28,875 is gross and to obtain the net saving an estimate should be made on the cost of conveying the apparatus, and proper allowances should be made for cost of power for operation, for maintenance, depreciation and interest at, say, 6 per cent on the cost of machinery installed. No deduction should be made for the labor in operating bulk cement apparatus as the second item in the table above represents the net labor saving, proper allowance having been made for the labor to operate bulk cement machinery.

Cutting Concrete Piles.—Precast concrete piles in the dock structure at the U. S. Army Base at Charleston, S. C., were cut to the proper elevation by sledging off the surface concrete about 3 ft. above the cutoff level and cutting the rods with a gas torch. The shaft concrete was then cut at the cutoff level with plug and feather, the 3 ft. of projecting rods being left for bonding purposes.

The Surface Area and Fineness Modulus Methods of Grading Concrete Aggregates

By DUFF A. ABRAMS,

Professor in Charge, Structural Materials Research [illegible] Lewis Institute, Chicago

In designing concrete mixtures, three elements must be kept in mind: (1) workability; (2) strength, or other desirable property, and (3) cost. Under usual circumstances each of these three factors is an absolute limitation on the makeup of the concrete. If cost were no item, concrete of any desired strength and workability could be secured by using rich mixtures. In order to reduce the cost to a minimum we use as much aggregate as feasible. The degree of workability required depends on the nature of the work and the methods used in handling and placing. The workability of concrete is one of its prime advantages and a certain degree of workability is absolutely essential. In order to reduce the cost of handling and placing to a minimum, a satisfactory degree of workability may be secured by using a little more water than is necessary, and an aggregate of somewhat greater fineness than that known to produce maximum strength of concrete. In designing concrete mixtures the engineer must work out a nice balance between the strength, cost and workability in order to secure an economical building material.

It has been pointed out that the function of water in concrete is two fold:

(1) To hydrate the cement.

(2) To form a plastic mass.

The quantity of water required to hydrate the cement has not been definitely determined; it is probable that not more than 25 to 40 per cent of the water in ordinary concrete is necessary for this purpose.

Tests made in this laboratory have shown that with given materials and conditions of test, the quantity of mixing water used determines the strength of the concrete so long as the following conditions are observed:

(1) Concrete is plastic with the method of placing used.

(2) Aggregate not too coarse for quantity of cement used.

(3) Mixture not so wet that all water cannot be held by the concrete.

Were it not for the plasticity of the material concrete construction would be impossible. The falling-off in strength due to aggregates being too coarse is illustrated in Fig. 3 of our Bulletin 1. (See Engineering and Contracting, April 23, 1919, page 423.) If the mixture is so wet that all water is not held, the strength will be somewhat higher than would be expected for this water ratio. However, this condition is not reached until we come to very wet mixtures which give extremely low strengths anyhow. The quantity of mixing water can be be expressed at a ratio to the volume of cement.

Regardless of the size or grading of the aggregate, the amount of cement or the consistency of the concrete, the "water-ratio" may be used as a measure of the strength of the concrete. In other words, it makes no difference why the water-ratio is changed; the fact that it is changed within the limits stated above produces a definite result. Other properties of concrete, such as wearing resistance, modulus of elasticity, etc., have been found to follow similar laws.

Captain Edwards* has not given sufficient weight to the fundamental relation between the water content and the strength of concrete. He states in his original paper that "the surface area method of proportioning concrete assumes as its basic principle that the physical properties are primarily dependent upon the relation of volume of cementing material to the surface areas of the aggregation." It seems to me that the tests reported fail to bear out this assumption.

On the other hand many different series of tests made in this laboratory have shown that the quantity of cement is not a criterion of the strength of the concrete unless at the same time we take into account the quantity of water used. A 1:9 mix may be as strong as a 1:2 mix. In other words, it is the ratio of water to cement that determines the strength of the concrete. Table III shows one way in which the quantity of cement may be varied 400 to 600 per cent without producing any appreciable effect on strength so long as the water-ratio is constant. Much greater variations in cement content could have been made had it seemed desirable.

Captain Edwards states that "the tests were made with the object of developing the surface-area method of proportioning . . ." Apparently the entire method of dealing with [illegible] from 9 different gradings of the same sand, using one quantity of cement (2 in the case of 3 gradings) and mixed to a single consistency. Each value was probably based on tests from a single batch. A few concrete tests were made, but it is stated "that in the proportioning of the cement content [illegible] stone aggregate." These concrete tests can therefore have little or no bearing on the surface-area method. The 9 sand gradings all gave smooth sieve analysis curves. All but two of the sands were of the same maximum size. This cannot be expected to be a severe test of a new method of proportioning.

The "water formula" for concrete cannot be reduced to the simple form given by Captain Edwards, if it is to be of general application. The following formula is from our Bulletin 1 [See Engineering and Contracting, April 25, 1919]:

[illegible]

[illegible] batch.

[illegible]

This water formula takes account of the following 6 factors:

(1) Relative consistency of concrete (workability [illegible]

(2) Normal consistency of cement.

(3) The mix (volume of cement).

(4) Size and grading of aggregate (measured by the fineness modulus).

(5) Absorption of aggregate.

(6) Moisture contained in aggregate.

Another term is necessary when an admixture is used. The items, with the exception of (1) and (4) can be readily determined for given materials. The amount of water required under (1) will depend on the nature of the work, the method of placing the concrete, etc. Any method which will [illegible] grading of the aggregate should give satisfactory results. This Captain Edwards has endeavored to accomplish by means of the surface-area factor, while we have used the fineness modulus of the aggregate.

The fineness modulus is the sum of the percentages in the sieve analysis of the aggregate, divided by 100. Sieves from the Tyler standard screen scale are used. The percentages are expressed in terms of the quantity of aggregate by weight or volume coarser than each of the sieves. For a particle of a given size the surface area and the fineness modulus bear a direct relation to each other, since they are both simple functions of the diameter. The surface area varies as the square of the diameter [illegible] logarithmic function of the diameter. The relation is not so simple when we come to deal with graded aggregates. The discrepancy in this case becomes so great that both of the methods cannot [illegible] tions.

A further discussion of the quantity of water required on the basis of the grading of aggregate may be of interest. The plasticity or workability of the finished concrete is the only criterion which can be used in comparing the water requirements of different mixes, gradings, etc. We have used the "slump" test for this purpose. This consists of molding the 6 by 12-in. cylinder in a smooth steel form by puddling the concrete in 4-in. layers with a ⅝-in steel bar, leveling off with a bricklayer's [illegible] form, without opening it, by a steady upward pull. The [illegible] ured in inches, is the "slump."

The water which must be added, due to the presence of the aggregate, aside from that absorbed, may be divided into two portions:

(1) To [illegible]

(2) To [illegible] plastic mix with the aggregate.

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*See Engineering and Contracting, Sept. [illegible] of Captain Edwards' paper on Surface Area Method [illegible] with concrete mixers. See also Captain Edwards' letter [illegible] 28 issue.

The total quantity of water required for this purpose can be determined experimentally by measuring the additional water necessary to produce a given plasticity in a concrete mixture as compared with that required for neat cement. By using different quantities of aggregate and different size and grading we arrived at the term,

$$\frac{0.30}{1.26^{m}}$$

in our water formula which takes account of this factor. (It will be noted that this term gives a relation between water and fineness modulus similar to the water-strength curve in Fig. 1 of Bulletin 1.) The total quantity of water required for this term in an ordinary concrete mixture is about 8 per cent by volume of concrete or 40 to 50 per cent of the total. This quantity is known to give satisfactory results. There is no reason why the water necessary to thin the cement paste should not be charged to the cement instead of the aggregate; however, the latter method seems more logical since it is the presence of the aggregate and its size and grading that ncessitates the addition of water to produce a mix of the same plasticity.

Let us see how much the quantity of water which must be charged to the aggregate (aside from that absorbed) is dependent upon surface area. Earl Pettijohn has shown (Jour. Am. Chem. Soc., April, 1919) that the thickness of the surface film of standard Ottawa sand is 0.00003 in. at the point when free water begins to form. This means that 18 cc. (about 1/20 pint) of water would be required to produce the surface film on a cubic foot of standard sand and a much smaller quantity for ordinary concrete aggregate. The water required for this purpose is negligible. In other words, practically the entire quantity of water necessary on account of size and grading of aggregates must be charged to thinning the cement paste.

Ordinary mixes require water-ratios of .75 to 1.00; the value for neat cement with a normal consistency of 23 per cent by weight is .35. In other words the cement in concrete contains two to three times as much water as that required for normal consistency. It is the dispersion of the cement particles which results from the addition of water that is responsible for the rapid reduction in strength found in the wetter mixes:

How must the thinness of this paste be varied in order to produce a plastic mix with aggregate of different size and grading? Upon thinning the paste by adding water, we observe the following phenomena:

(1) Increased plasticity,

(2) Change in volume.

The increased plasticity arising from adding water needs no demonstration. The volume of paste is first reduced, then increased as water is added to cement. Table I shows the effect with a standard cement weighing 94 lb. per cu. ft.

TABLE I—VOLUME OF CEMENT PASTE

(Water added to 1 vol. of dry cement.)

Water-ratio.	Water in terms of normal consistency	Volume of cement paste.
.35	1.00	.87
.40	1.14	.89
.50	1.43	.98
.60	1.71	1.06
.75	2.14	1.20
1.00	2.90	1.42
1.50	4.3	1.93
2.00	5.7	2.40
3.00	8.6	3.20

That the volume of paste is an important factor in producing plasticity of mix can readily be seen from the fact that plasticity can be increased by increasing the quantity of cement and using relatively less water; in other words, a given degree of plasticity is produced by a low-water ratio for a rich mix and a high water-ratio with a lean mix. Just what effect the actual quantities of paste has on workability under the extreme conditions of mix, etc., has not been determined.

Current theories of concrete are generally based on the idea that the quantity of paste is dictated by the voids in the aggregate, with a certain surplus. Four weaknesses in this theory may be mentioned:

(1) The voids in the aggregate can be varied widely without producing any change in the quality of concrete:

(2) The grading of aggregate which gives greatest strength in concrete gives higher voids than are found in other gradings of lower strengths;

(3) Concrete of highest strength may contain visible voids;

(4) The strength and other desirable properties of the concrete depends on the quality of the paste and is little affected by the quantity, so long as we have sufficient to produce a workable mix.

The influence of the cement-water mixture on the plasticity of concrete is then a function jointly of the plasticity and volume of the paste. We have seen that the strength is a function of the water-ratio (volume of water to volume of cement) and that the strength of concrete decreases as the water-ratio increases; hence, in order to secure the highest grade of concrete at the lowest cost it is necessary to secure a given condition of plasticity with a minimum water-ratio. What condition with reference to the size and grading of the aggregate will give the desired result? It is obvious that this is a most complex relation if we consider the almost infinite variety of sizes and gradings which may be made from a single aggregate. Captain Edwards has used the surface areas as a satisfactory measure. It seems to the writer that the radius of curvature of the particles and the number of points of contact (or near contact) between adjacent particles are the factors which are primarily responsible for the additional water which is necessary due to the presence of the aggregate. Both of these factors are functions of the diameter; the radius of curvature is one-half the diameter, if we assume that aggregate of spherical form is being used. Since particles of all sizes are mixed at random and there is no systematic arrangement, it is impossible to analyze the problem in a way that will enable us to compute the number of points of contact. The only practical method then is to determine the relation by trial. The fineness modulus method was arrived at in this way. It was discovered from a study of mortar strength tests of about 1,000 different sands mixed to a uniform plasticity, and stored and tested under uniform conditions.

The water formula given in our Bulletin 1 is of a rational form and can be applied to any combination of concrete materials. Its development was an evolution extending over several years. These formulas were numbered in the order of their derivation as they were modified from time to time on the basis of experience. The above formula is No. 11. It is based on the experience of many thousand tests. I do not mean to be understood as believing that this formula is exact and will require no further modification. On the other hand, subsequent experience may dictate certain changes.

The formula has been subjected to many severe tests by applying it to aggregate of the most diverse character. A recent series of tests using 4 different coarse aggregates (graded No. 4 sieve to 1½ in.) and the same sand gave the following results for 1-4 mixes:

TABLE II—STRENGTH OF CONCRETE FROM FOUR AGGREGATES.

Coarse aggregate.	Compressive strength (lb. per sq. in.).
Pebbles	3,620
Crushed limestone	3,830
Crushed slag	3,750
Crushed granite	3,850

Tests were made on 6 by 12-in. cylinders at the age of 3 months. Twenty-one different gradings were used for each coarse aggregate. Specimens were stored under two conditions. Each value given above is the average of 105 tests. The water for these concretes was proportioned by the formula given above. The fact that with similar gradings and water properly controlled we secure uniform plasticity and strength, is a severe test on the formula, when it is considered that we are comparing spherical and crushed materials of widely different characteristics. The absorption of the aggregate was also different in each case. Many serious errors have been made by experimentors in comparing the concrete-making qualities of different aggregates. The wide variations reported in the strength of the concrete made from different materials can almost invariably be traced to failure to take account of differences in size or grading and to neglect of the absorption of aggregates.

The sand mortar tests in Captain Edwards' paper, which were mixed with 1 volume of cement for each 13 sq. in. of calculated surface area of the sand gave mortars of fairly uniform strengths at 3 different ages. These tests are interpreted as proving that the surface area of the aggregate is a proper basis for proportioning mortar and concrete mixtures. It is the writer's view that the uniformity in strength is due to an entirely different cause. Since both the water and cement were proportioned on the basis of the surface area of the aggregates, he obtained a uniform water-ratio, which is solely responsible for the uniform strength. This is the result to be expected so long as all of the mixtures were plastic and none of the aggregate gradings were too coarse for the quantity of cement used.

It is unfortunate that it was not feasible to include in our Bulletin 1 all of the data on which the conclusions were based. It is the writer's belief, however, that the tests given in Table II of the Bulletin bring out a fatal limitation of the surface-area method of dealing with proportioning of aggregates. Twenty-seven different gradings of the same aggregate were used. The gradings were made to vary over a wide range, but had one property in common, that is, the fineness modulus was uniform. They were mixed with the same proportions of cement and water. The strengths for two different consistencies showed a mean variation from the average of about 3 per cent, and a maximum variation from the average of about 10 per cent. The corresponding values for surface areas are 34 per cent and 110 per cent respectively. If the water proportioning of these tests had been based on Captain Edwards' formula, the water-ratios of the concrete would range from 0.39 to 0.57, an extreme variation of 69 per cent, and would have made a very great difference in the plasticity of the concrete. It is true, as stated in Captain Edwards' letter, that these tests were made with a view to determining whether or not a uniform strength of concrete was obtained with such wide variations in the sieve analysis of the aggregates. However, the plasticity or workability of the concrete did not differ materially. The surface-area values in our table were calculated from the diagrams given in Captain Edwards' paper. It was necessary to estimate the areas of the sand particles below the 100-mesh sieve, and wide variations may be due to this cause. In certain of the tests as much as 10 per cent of the aggregate was sand finer than the 100-mesh sieve. The surface area of this portion which we must estimate or neglect entirely, is probably considerably greater than the entire surface area of many other gradings in the same group.

The quantities of water given by Captain Edwards' formula are only 60 to 70 per cent of those required for the materials used in this laboratory. It was impossible to mix concrete using the water given by his formula.

Let us consider the tests reported in Fig. 11 of the paper by Captain Edwards, in which all of the coarse aggregate in a 1-2-4 mixture was screened out of the fresh concrete for the purpose of leaving the cement, sand and water as in the original mixture. If our conclusion is correct we would expect to secure the same strength in these two instances. Whereas the strength with the fine aggregate only, varies from 22 per cent at 7 days and 31 per cent at 60 days higher than the original concrete. This discrepancy is attributed to "the weakening effect of cleavage planes produced by the stone aggregate." This explanation is undoubtedly erroneous. The discrepancy should be attributed to one or more of the following causes:

(1) Absorption of a proportion of the water by the coarse aggregate.

(2) The loss of water due to adhesion to the coarse aggregate.

(3) Variations due to size of test pieces.

(4) Different curing conditions.

This method of varying the proportions has been studied in two series covering several thousand tests made in this laboratory. The tests were made in this manner for the reason that we can secure a wider range in water-ratio than is practicable with the ordinary variations in mixes, etc. When the same size of test cylinder is used and the concrete is made, cured and tested under similar conditions we find a uniform strength. Table III gives the results from a portion of the tests in the earlier series. Two leaner and two richer groups of mixtures are omitted. The quantity of materials required for each specimen beginning with the 0-1½ in. aggregate and a mix of 1-2½-5, 1-2-4, 1-1½-3, etc. was calculated. The coarser sizes of aggregate were dropped in turn, but we retained exactly the same quantity of cement and water. The final mixes in terms of volume of cement and total aggregate are given in column 2 of the table. It is obvious that the richer mixers in each group are much more plastic than the leaner ones, and that equal workability was not secured. As in all other tests in these investigations, the concrete for each cylinder was mixed separately by hand. Each value is the average of 5 tests made on different days. The second series of tests is not yet completed, however, the tests which have been made show a greater uniformity in strength than those in Table III, due to slight readjustments of certain constants in the water formula. These tests confirm the conclusion based on many other series; namely that the widest variations may be made in the mix, consistency, and size of aggregate without any change in strength so long as the water-ratio is unchanged, and the limitations given above are not violated.

I am at a loss to understand the basis of the table of comparative properties which Captain Edwards gives. It is stated in this table that the fineness modulus method gives

TABLE III—EFFECT OF SIZE AND GRADING OF AGGREGATE [illegible]

Compression tests [illegible] Hand-mixed concrete [illegible] and tested damp [illegible] average of 5 tests [illegible]

(1)	[illegible]	[illegible]	(4)	(5)	(6)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
				Nominal mix for 0-1½-in. [illegible]									
15	1-[illegible]	1.00	[illegible]	0-1½	5.67	125	[illegible]	[illegible]	[illegible]	15[illegible]	[illegible]	1,006	1,800
16	1-[illegible]	1.05	[illegible]	0-¾	5.[illegible]	124	[illegible]	1[illegible]	[illegible]	151	[illegible]	1,115	1,760
17	1-[illegible]	1.1[illegible]	[illegible]	0-⅜	4.10	121	.725	1,737	[illegible]	[illegible]	6[illegible]8	1,241	1,95[illegible]
18	1-[illegible]	1.2[illegible]	[illegible]	0-4	2.[illegible]	1[illegible]	.671	2,601	7,750	13[illegible]	646	1,29[illegible]	[illegible]
19	1-[illegible]	1.23	.91	0-8	[illegible]	[illegible]	.648	3,056	7,730	[illegible]	[illegible]	[illegible]	[illegible]
20	1-1.[illegible]	1.29	[illegible]	0-14	[illegible]	105	.629	3,695	7,840	[illegible]	643	1,377	1,940
21	1-1.[illegible]	1.50	.91	0-28	1.[illegible]	[illegible]	611	4,194	[illegible]	[illegible]	603	[illegible]	2,000
				Nominal mix [illegible] —1-2-4.									
22	1-[illegible]	1.00	.80	0-1½	5.67	[illegible]	.755	[illegible]	[illegible]	[illegible]	842	[illegible]	2,230
23	1-[illegible]	1.05	[illegible]	0-¾	[illegible]	[illegible]	.743	1,052	[illegible]	[illegible]	[illegible]	[illegible]	2,130
24	1-[illegible]	1.13	[illegible]	0-⅜	4.10	121	.725	1,737	[illegible]	[illegible]	754	1,183	2,550
25	1-[illegible]	1.20	.80	0-4	3.00	[illegible]	.671	2,604	6,210	139	69[illegible]	[illegible]	2,150
26	1-[illegible]	1.22	[illegible]	[illegible]	[illegible]	[illegible]	.648	[illegible]	5,970	[illegible]	[illegible]	[illegible]	2,280
27	1-[illegible]	1.2[illegible]	[illegible]	0-14	[illegible]	[illegible]	.629	3,695	[illegible]	[illegible]	[illegible]	1,52[illegible]	2,400
28	1-[illegible]	1.47	[illegible]	0-28	1.81	[illegible]	611	[illegible]	[illegible]	135	[illegible]	[illegible]	2,310
				Nominal mix [illegible]									
29	1-4.0	1.00	[illegible]	0-1½	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	832	1,120	3,100
30	1-3.2	1.04	[illegible]	[illegible]	[illegible]	[illegible]	.743	1,052	[illegible]	[illegible]	[illegible]	1,273	2,970
31	1-2.2	1.11	[illegible]	0-⅜	4.10	[illegible]	.725	1,737	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
32	1-1.5	1.16	[illegible]	0-4	[illegible]	[illegible]	[illegible]	2,601	[illegible]	139	[illegible]	1,570	[illegible]20
33	1-1.3	1.20	[illegible]	0-8	2.78	[illegible]	[illegible]	3,056	[illegible]	136	[illegible]	1,7[illegible]0	[illegible]
34	1-1.1	1.22	[illegible]	0-14	2.21	[illegible]	.629	3,695	[illegible]	132	[illegible]	2,[illegible]08	[illegible]
35	1-[illegible]	[illegible]	[illegible]	0-28	1[illegible]	102	611	[illegible]	[illegible]	129	[illegible]	[illegible]	[illegible]
36	1-[illegible]	[illegible]	[illegible]		Neat					132			

*Fineness modulus of aggregate.

†Yield was calculated [illegible]

[illegible] particle. No evidence is submitted to show that this is the case. On the other hand, wide experience in this laboratory has shown that the [illegible] is erroneous. The portion of our water formula which takes account of the grading of aggregates is based on tests covering the widest possible range in the proportions of the concrete materials. The aggregates used ranged from sand all of which passed a 100-mesh sieve to concrete aggregate graded up to 2 in. in size; mixes from 1:15 to neat cement, and consistencies from dry to very sloppy.

It is also stated that the "toughness" is variable with the fineness modulus method but is uniform with the surface-area method. So far as I am aware no studies have been made by any one which would justify such a comparison. We have made a thorough study of the wearing resistance of concrete of a wide range in proportions which shows that for given materials and conditions of test the wear is a function of the water-ratio. (See "Effect of Time of Mixing Concrete," Proc. Am. Concr. Inst. 1918, and "Effect of Curing Condition on the Wear and Strength of Concrete," Bulletin 2 of this laboratory.)

It seems to the writer that any comparison of the surface area and fineness modulus methods must be reduced to the following two items:

(1) Which rests on the most sound experimental basis?

(2) Which is the most simple to apply?

As stated above, the whole question of the comparison between the two methods resolves itself into that of determining which will give the best distribution of water in a mix, so far as the size and grading of the aggregates are concerned. Both of these methods make use of the sieve analysis of the aggregate. However, it seems to the writer that there is more variation in the underlying principles than that suggested in the last paragraph of Captain Edwards' letter.

It appears that the following disadvantages accompany the use of the surface-area method:

(1) Areas of the finest particles of sand cannot be computed.

(2) Crushed aggregate requires a greater quantity of water for the same grading than pebbles of a spherical form.

(3) If the surface-area method were strictly interpreted it would require separate treatment for practically each kind of aggregate.

(4) The method requires laborious computation, with the resulting chance of error.

(5) It is not clear how the method can be applied to the simplest problems which arise in the course of designing concrete mixtures; for instance, to determine the best proportions of given fine and coarse aggregates for a concrete mixture.

(6) It has not been shown that there is any theoretical reason why the surface-area method gives more nearly correct results than other methods which have been proposed.

If the surface-area method is correct it would seem to be a serious fault that the areas of the finest particles cannot be satisfactorily dealt with. It seems probable that in extreme cases the areas of the particles finer than the 100-mesh sieve would be in excess of the combined areas of the coarser sizes. Our experience indicates that the quantity of water required for these fine sands is not in proportion to the amount that would be suggested by the surface areas.

The area of a tetrahedron is 25 to 30 per cent greater than that of a sphere of the same volume, or one having a diameter equal to the height of the tetrahedron. Our experience in testing concrete made of crushed aggregates as compared with rounded pebbles does not indicate that there is any discrepancy in the quantity of water required as would be suggested by the surface-area method.

The computation of surface areas begins at practically the same point where the determination of the fineness modulus ends. There appears to be little room for question as to which of the proposed methods is the more simple in application.

Methods of determining the proportions of materials required from given aggregates is an important feature of the fineness modulus method and is fully explained in Bulletin 1.

No doubt the surface-area method could be worked out so that it would apply over a limited range. In fact almost any function of the size of particle could be used in this way. This would be equivalent to representing a portion of the curve by a line or by an arc of different curvature. The choice of method used should lie with the one which is most simple and direct in its application and which at the same time is known to give satisfactory results.

It is unfortunate that the wording in our Bulletin 1 was such as to permit the interpretation which is placed upon it by Captain Edwards in his letter. The thought the writer meant to convey was not at all the meaning that Captain Edwards finds in the report. The purpose was to indicate that the size of the aggregate may vary over a wide range without producing any effect on the concrete strength, so long as the concrete and water remain unchanged, for instance as in Table III. The confusion arises from the use of the terms size and grading interchangeably and to the use of both of them in a multitude of different senses. It was not intended that the statement should apply to the case of aggregates having the same fineness modulus, such as those given in Table II, Bulletin 1.

Captain Edwards attributed the volumetric method of proportioning concrete materials to General Pasley, 1827; however, this method is referred to by a number of earlier writers. It is frequently mentioned in Vicat's book on Mortars and Cements, published originally in French in 1818. This method of proportioning lime mortars was a matter of common knowledge among the ancients, as is shown by the following quotation from Vitruvius on "Architecture" written probably 100 years before the Christian era:

"[illegible] If pit sand be used, three parts of sand are mixed with one of lime. If river or sea sand be made use of, two parts of sand are given to one of lime . . . . " (Book 2, chap. 5).

The idea of basing a discussion of concrete on the surface area of aggregate is expressed by a number of earlier writers. The language of Feret in "Chemie Applique," 1897, may be translated as follows:

". . . . there exists no simple law permitting the predetermination, in all cases, of the water necessary for a mix of good consistency in a mortar of any composition. In general, such proportions vary with the richness of the mix and with the fineness of the sand. However, if one limits the comparison of the water content to mortars the compositions of which do not present too many big differences, one is able to use a straight line tangent to the curve F. C. (referring to an adjacent figure) at the desired point, and determine the water as made up of two parts; the first forming the water necessary to produce normal consistency of cement, and second, the amount necessary to moisten the sand, which is proportional to the total surface of the grains."

The idea is definitely expressed by General Gillmore in his book on Limes, Hydraulic Cements and Mortars, written in 1863.

Effect of Number of Coats on the Moisture Resistance of Spar Varnish

Recent experiments at the Forest Products Laboratory have provided some information concerning the relative protection against water afforded by various numbers of coats of spar varnish.

For these experiments three varnishes were selected from about forty brands tested, the first varnish being one of the best of the forty, the second a little better than the average, and the third a little below the average. From two to twelve coats of each varnish were applied to panels of yellow birch, which were then exposed 17 days to a humidity of 100 per cent. The results are given in Table I.

TABLE I. COMPARATIVE REDUCTION IN ABSORPTION OF MOISTURE AND SWELLING CAUSED BY DIFFERENT NUMBERS OF COATS OF SPAR VARNISH EXPOSED FOR A PERIOD OF 17 DAYS IN A SATURATED ATMOSPHERE

No. of coats of spar varnish.	Percentage of moisture excluded (based on untreated specimens) 1st varnish.	2nd varnish.	3rd varnish.	Percentage of increase in width due to absorption of moisture 1st varnish.	2nd varnish.	3rd varnish.
0	0.0	0.0	0.0	8.61	8.61	8.62
2	[illegible]	72.0	65.5	2.01	2.41	2.97
4	86.2	75.8	76.9	1.19	2.08	1.99
6	88.6	81.7	82.0	0.98	1.57	1.46
8	91.6	86.9	86.2	0.77	1.30	1.19
10	93.0	88.4	87.3	0.60	1.00	1.09
12	94.3	89.0	87.2	0.49	0.90	1.10

It will be noted that two coats of the first varnish were about as effective as four coats of either of the other two, and that four coats of the first varnish were about as effective as six to twelve coats of either of the others.

Graphical Differentiation and Integration

Since the appearance of "Graphical Statics" by Professor Du Bois in 1875, the American press has published many text books dealing with the graphic solution of engineering problems. From that date and for thirty or more years thereafter, many technical schools and colleges offered courses in which the graphic treatment was divorced from the algebraic or (more commonly but improperly called) analytic treatment. We are glad to note that this system is rapidly falling into disfavor, and that the algebraic and graphic methods of solution are being united in the engineering courses of the present. This is as it should be.

The question—Which method is the better?—is one which functions with the individual problem; but when both methods are employed, the fundamentals are more clearly set before the student.

Mathematicians will do well to follow the example set by the teachers of Mechanics and Structures and introduce graphic methods in their courses in Calculus, thereby aiding the student in getting what he so frequently misses, viz., the fundamental concept of Calculus.

The paper on "Graphical Differentiation and Integration" by Professor Theodore R. Running in the March number of the "Michigan Technic" is timely. A somewhat similar treatment, with many applications to shear and moment digrams, is presented in the "Journal of the Western Society of Engineers," April, 1917, by Professor Charles A. Ellis. The ease with which problems may be solved by graphics is well illustrated in Professor Running's article which follows.

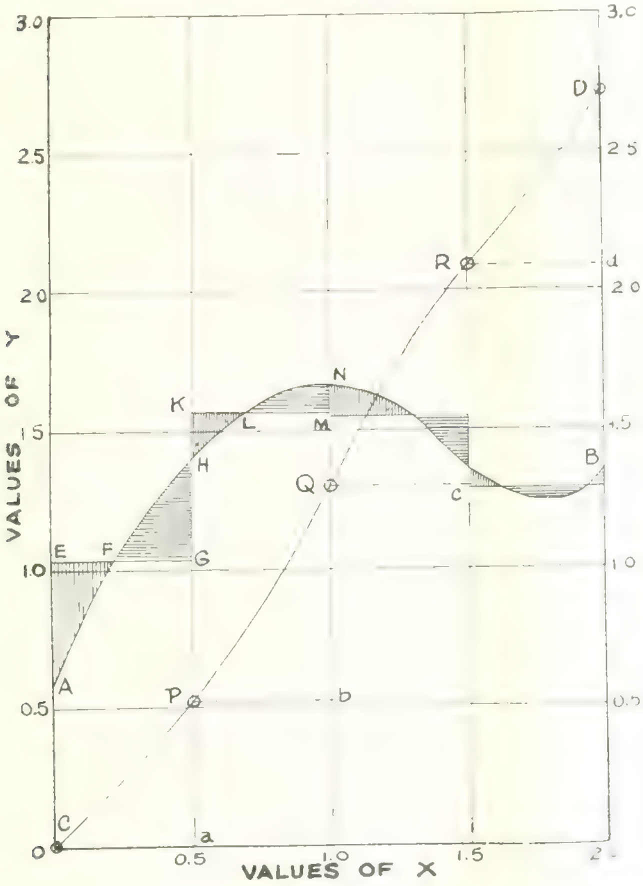

Fig 1

It is not the purpose of this article to explain the different methods for differentiating and integrating graphically but to set forth in its simplest form one method which, in the judgment of the writer, is the most accurate, and, at the same time, most easily carried out. The method applies equally well to tabulated functions and to functions represented by curves. The method depends upon the principle of areas.

Many of the problems in the varied fields of engineering and applied science involve the principles of the calculus. These problems, when they arise from a consideration of observed data, do not often lend themselves to a direct application of differentiation or integration formulas. They are frequently of such a nature that accurate results are neither necessary nor possible. The "allowable error" is an important consideration when taking up the work of solving such problems.

It is known that if the data used as a basis may be in error as much as one per cent it would manifestly be needless to employ computation which yields a higher degree of accuracy. Any mechanical means for obtaining results to a sufficient degree of accuracy with the least amount of effort will not only be a saving of time and mental wear, but will also lessen the probability of error.

Graphical representation of data, graphical computation, and graphical solution of formulas are processes well known and often employed. Graphical differentiation and graphical integration, however, are often replaced by cumbersome and less accurate methods. It is indeed in the application to [illegible] useful.

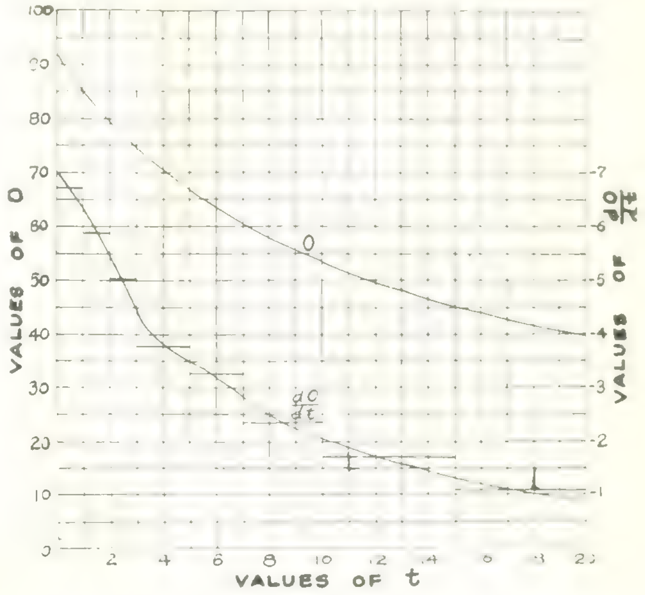

Fig. 2.

Graphical methods in general have a decided advantage over numerical processes in one respect; they place before the eye more clearly and strikingly the relation between the elements which enter into a given problem. Any error which may materially affect the result is at once detected by the [illegible]

Consider the curve AB, Fig. 1, the integral curve of which is to be constructed. From calculus the area under the [illegible] represented by the definite integral

$$[illegible] \int [illegible]$$

[illegible] stands for the [illegible] and Y for the area. If now the area is taken from x = 0 to x = 0.5, and this area represented by an ordinate, it will locate a point P on the integral curve. If the integral be taken from x = 0 to x = 1, that is a = 1, and this area represented as an ordinate, it will locate the point Q on the integral curve.

Graphically these areas are determined as follows: Draw [illegible] equal to the area FG[illegible] of approximation, for the eye is a very good judge of the equality of small areas [illegible] will be equal to the area under the curve AH. This area is then computed and the number of square units in this area represented by the ordinate aP. Draw a line KM so that the area HKL is equal to LMN then the area in the rectangle aM will be equal to the area under the curve HN. This area is represented by the line bQ, and the area under the curve AN will be represented by the ordinate of the point Q. After a number of points are determined as above, a smooth curve is drawn through them. This is the integral curve. It is here assumed that the constant of integration is such that the integral curve passes through the origin.

This process can be reversed. Given the curve OP it is required to find the derived curve. The process is as follows: Measure the length of the line aP. This will represent the number of square units under the derived curve bounded by x=o and x=0.5. Having this area the rectangle OQ is then constructed. The length of the line bQ will represent the number of square units in the area under the derived curve from x=0.5 to x=1. Having this area the rectangle aM is similarly constructed. So, also the length of the line cR will represent the area under the derived curve from x=1 to x=1.5. The above statements become evident from the definite integral

$$\int_{x_1}^{x_2} y\,dx = Y_2 - Y_1$$

where y is the ordinate on the derived curve and Y_1 and Y_2 are ordinates on the integral curve corresponding to x_1 and x_2.

Now if a smooth curve AB be drawn such that the areas have the relation described in the integration the derived curve is obtained. An illustration is given below. The observed temperature O in degrees centigrade of a vessel of cooling water at time t in minutes from the first observation is given in the following table:

t	0	1	2	3	5	7	10	15	20
O	92.0	85.3	79.5	74.5	67.0	60.5	53.5	45.0	39.5

In Fig. 2 the curve represented in these data is determined by O. The difference between the values of O corresponding to t=o and t=1 is —6.7. This represents the area under the derived curve from t=o to t=1 and since it is negative, should be drawn below the t—axis, but for the purpose of economy in space is drawn above it and the values of dO/dt indicated as negative. This area is represented in the figure by a rectangle whose upper boundary is drawn. The difference between the values of O corresponding to t=1 and t=2 which is —5.8, is represented by the rectangle whose upper boundary is indicated between t=1 and t=2. The other marking the upper boundaries of rectangles is obtained in the same way.

A smooth curve is now drawn as described under graphical differentiation. This is the derived curve and is designated by dO/dt. The ordinates of this curve are the slopes at the corresponding points on the O curve. The ordinates on the derived curve represent the time rate of change of temperature. The process of finding the second derived curve is evident and needs no further explanation.

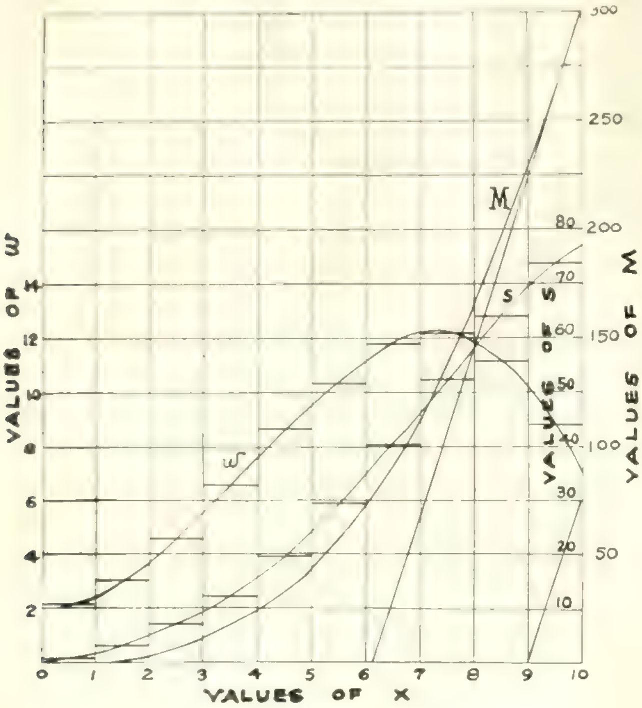

Fig. 3.

The following is an illustration of integration: A beam 10 ft. long is loaded as in the table below, where w is the weight per unit length at the distance x ft. from the free end.

x	0	1	2	3	4	5	6	7	8	9	10
w	[illegible]	[illegible]	3.7	5.5	[illegible]	9.7	11.2	12.2	11.8	10.2	7.2

Let it be required

1. to draw the integral curves to show

a. the shearing force, $s = \int w\,dx$.

b. the bending moment, $M = \int s\,dx$.

2. To locate the position of the centroid along the beam.

The curve determined by sets of values of x and w is designated by w in Fig. 3. This curve is integrated as was explained at the outset, the horizontal lines indicating the upper boundaries of the rectangles. In this way the curve marked S is obtained. Any ordinate on the curve represents the shearing force on that section.

This curve is integrated and the curve marked M in the figure is obtained. Any ordinate on this curve represents the bending moment about the section containing the ordinate. If the value of M be divided by the value of S at x=10, the position of the centroid is at once obtained. This is done graphically and is found to be approximately 6.2 ft. to the right of the free end.

The proof that the curve M in Fig. 3 is the moment curve is quite simple. From calculus, the moment of the weight to the left of any section, x=a, about that section is expressed by the definite integral

$$M = \int_0^a (a - x)\,w\,dx$$

Integrating this by parts and remembering that both a and w are variable, we obtain

$$M = (x - a)\int w\,dx + \iint w\,dx\,dx$$

the first term in this expression is zero when x=o, and it is also equal to zero when x=a. It appears then that

$$\int (a - x)\,w\,dx = \iint w\,dx\,dx$$

the right hand member is but a repeated integral which gives the curve, M.

This process could easily be extended to moments of intertia, but enough has been given for illustration. It might be added that integrating the M curve in Fig. 3 will give a curve whose ordinates represent one-half of the moment of inertia about the section containing the ordinate.

Handling Building Material in Motor Trucks

In a letter in Concrete, Mr. G. E. Dale, Treasurer of the Downey Contracting Co., Philadelphia, gives some particulars of the motor truck operations of his company. The company is operating about 70 trucks, both stake and dump bodies, and 20 van bodies, the latter being used for inter-city hauling.

The trailers are used primarily for the hauling of long concrete reinforcing steel bars, although they are used occasionally for transporting contractors' equipment, such as derricks, booms or other pieces of machinery, which would be too long for a single truck to handle.

The dump bodies are used in the transporting of sand, gravel and other material to concrete jobs.

The company is unloading from boats and hauling direct to the job, increasing the cost of hauling, but saving the railroad freight, which nets the contractor a saving over the old method of getting in by cars.

Trucks and trailers are used in unloading cement from cars, three trailers often being used with one truck. By this method a truck and trailer are loaded and started to the job, leaving one trailer to be loaded at the car. When the truck and trailer arrives at the job the truck is unloaded first and started back empty to the car, leaving the trailer to be unloaded, while the truck is gone. When the truck gets back at the car it is loaded and during its absence the trailer has also been loaded. Both of these are pulled to the job, the truck unloaded and returned with the first trailer, which has been unloaded while the truck was gone, leaving the second trailer at the job to be unloaded. In this way it keeps men busy at each end loading and unloading and there is no delay or break in their work.

A New Principle in the Theory of Structures*

This paper explains what is believed to be a new principle in the theory of structures, which has interesting and important applications. It is known that there is little new under the sun, and it may be that this principle has been known, and published elsewhere, but the writer has not seen it, and has arrived at it independently, from his own reflections on the subject.†

Deflection of a Point.– The deflection of any point, A, of any structure may be found by a well-known formula, first published in America by the writer in 1883.‡ This formula is

$$\Delta = \sum \frac{EA}{s\,t\,l} \quad \ldots\ldots \quad (1)§$$

in which

t = stress in any member due solely to a load of unity acting at the point the deflection of which, is desired, under the given actual loads, in the direction in which said deflection is desired;

s = stress in the same member, due solely to the given actual loads;

l = length of the same member;

A = area of the same member;

E = modulus of elasticity of the same member.

This formula, as is well known, may be applied, not only to finding the deflection of a joint of a framed structure, but also to finding the deflection of any point of a beam. In the latter case, the area, A, must be replaced by an infinitesimal area, da, and the stresses, s and t, must be the stresses on such area. If the case is one of pure flexure, with no resultant axial force on any section, and if M_t is the bending moment due solely to the force, unity, and M_s is the bending moment due to the actual loads, at any given section, the formula becomes

$$\Delta = \int \frac{M_t\,M_s\,dl}{EI} \quad \ldots\ldots \quad (2)$$

the integral being extended over the entire length.

The principle now to be explained is a similar one which affords a means of finding the rotation of the axis of any piece at any point.

Angular Rotation of the Axis of a Piece at a Point. (The New Principle).—In addition to finding the deflection of any point of a structure in any given direction, it is often desired to find the angular rotation at a point, i. e., the change of direction of the axis of a piece. This may be obtained by a general method analogous to that used for finding the deflection.

Let it be desired to find the angular rotation, or change of direction of the axis of a piece, at a given point, A, due to any given loads. At the given point apply only a couple the moment, M, of which equals unity, and let the corresponding angular rotation, α, at A be first determined by the method of work. (It may be thought a contradiction, or an impossibility, to apply a couple at a point, but this obviously is the same as applying two very large forces a very short distance apart, or two forces each equal to $\frac{1}{dx}$ at a distance, d x, apart. This is perfectly conceivable.) The work done by the couple the moment of which is M = 1, if gradually applied, will obviously be $\frac{\alpha}{2}$, since the couple may be considered to consist of forces of unity a unit distance apart, and its average value is $\frac{1}{2}$. The only outer forces being this couple, the work of these outer forces is [illegible] and this must equal the work of the inner forces. On any bar or fiber having a uniform stress intensity throughout its area and length, due to the applied moment, M = 1, let r equal the total direct stress on the bar or fiber and Δ l its change of length. Then the equation between the work of the outer forces and that of the inner forces is

$$\frac{\alpha}{2} = \sum \frac{1}{2} [illegible]$$

Now, as in the case of deflection, it is clear that the deformation is a purely geometrical phenomenon, and that any change of length of a bar or fiber, whatever its cause, will produce the same angular rotation at A. Hence, if for "change of length" in the above formula, which is the change of length due to M = 1 at A, we substitute the change of length due to any given loading, the formula will give the angular rotation at A due to the given loading, or

$$\alpha = \sum \frac{r\,s\,l}{E\,A} \quad \ldots\ldots \quad (3)$$

in which, for any given bar or fiber,

E = modulus of elasticity;

A = area;

l = length;

r = stress on the area, A, due to the couple, M = 1, at the given point in a given sense;

s = stress on the area, A, due to the applied loads.

The applied couple, M, may be applied with either a right-handed or left-handed direction of rotation. If α comes positive, this means that the given loads produce a rotation in the same direction as that assumed for M.

In using this equation, tension and compression, of course, should be distinguished in sign, carefully using one of these terms consistently as positive and the other as negative.

If the stresses include bending stresses, the elementary fibers, da in area and dl in length, must be taken.

The formula shows the effect of direct stresses only, shearing effects being neglected.

In applying the couple, M = 1, bending stresses may be produced in a bar, in addition to a direct stress in the same bar. The applied loads may produce bending or direct stresses, or both, in any bar. In such cases, for any fiber, s and r are the stresses on an area, da.

In general, if the applied loads cause in any bar at any section a direct force, T_s, and a flexural moment, M_s, the value of s will be

$$s = \left(\frac{T_s}{A} + \frac{M_s\,y}{I}\right) da$$

and if the couple, M = 1, produces in the same bar and section a direct force, T_r, and a moment, M, the value of r will be

$$r = \left(\frac{T_r}{A} + \frac{M_r\,y}{I}\right) da$$

The value of the differential, d α, therefore, will be

$$d\alpha = \frac{1}{E}\left(\frac{T_s}{A} + \frac{M_s\,y}{I}\right)\left(\frac{T_r}{A} + \frac{M_r\,y}{I}\right) da\,dl$$

$$= \frac{1}{E}\left[\frac{T_r\,T_s\,da\,dl}{A^2} + \frac{[illegible]\,da\,dl}{AI} + \frac{T_r\,M_s\,y\,.da\,.dl}{AI} + \frac{M_s\,M_r\,y^2.da\,.dl}{I^2}\right]$$

It is supposed that every bar is straight, with one principal axis of each cross-section in the plane of the applied loads, in which plane also the couple, M = 1, is applied. I is the moment of inertia about the principal axis perpendicular to that plane, which, of course passes through the center of gravity of the section [illegible].

This differential refers to an infinitesimal length, dl, of any fiber of area, da, in any bar, and must be integrated over the cross-section, then over the length of the bar, and the sum of the results taken. The final result will easily be seen to [illegible] constant throughout the length of each bar

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*From an article by Professor George F. Swain in the [illegible] Proceedings of the American Society of Civil Engineers.

†In Mohr's "Abhandlungen aus dem Gebiete der Technischen Mechanik," p. 125, this principle is [illegible] but it is not [illegible] explained or its general application [illegible]. The same thing is referred to in Grimm's book on Secondary Stresses, but not [illegible] elucidated.

‡In a paper, entitled "On the Application of the Principle of Virtual Velocities to the Determination of the Deflection and Stresses of Frames," in the Journal of the Franklin Institute [illegible].

§This equation is frequently written $\sum \frac{P\,u\,l}{A\,E}$ (Editor.)

$$\alpha = \Sigma \frac{T T_1 l}{E A} + \Sigma \int \frac{M M_1 d l}{E I} \qquad (4)$$

The forces T and T₁ are the direct forces acting in any bar and are supposed to be constant throughout its length, and the moments M and M₁ are the bending moments at any section of any bar. Each of the forces, T and T₁, in Equation (4), may in any bar represent a direct stress only, a flexural stress only, or zero. The following results clearly follow from Equation (4).

1.—If in any bar either the actual load system, or the applied moment, M = 1, causes a direct stress only and the other a flexural stress only, that bar may be neglected in the computation, for the value for that bar is zero.

2.—The flexure in any bar may be neglected unless both the actual loads and the applied moment, M = 1, cause flexural stress in it.

3.—The direct stress in any bar may be neglected unless both the actual loads and the applied moment, M = 1, cause a direct stress in it.

4.—If the case is one in which there is only flexural stress in the bars, without direct stress, the formula becomes,

$$\alpha = \Sigma \int_0 \frac{M M_1 d l}{E I} \qquad (5)$$

5.—If A as well as T varies along the length of any bar, the formula becomes

$$\alpha = \Sigma \int \frac{T T_1 d l}{E A} + \Sigma \int \frac{M M_1 d l}{E I} \qquad (6)$$

These principles apply in using Equation (1), to determine deflection, as in Equation (4), to determine rotation.

Illustrations of Angular Rotation.—Although this method would seldom or never be used to find the slope of a beam exposed to flexure, this case may be illustrated to show the applicability of the method.

Case I.—Slope of a Beam Fixed at One End.—Let it be desired to ascertain the slope of the free end of a beam of a constant section (Fig 1), fixed at one end and loaded at the other with a load, P. The load, P, produces on any section, distant x from the end, a moment $M_s = -Px$. The applied couple, M = 1, at the free end, if acting in the sense shown, likewise produces a moment at the same section, $M_r = -1$. There is no resultant direct stress on any cross-section. Hence by Equation (5),

$$\alpha = \int_0^l \frac{P x\, d x}{E I} = \frac{P l^2}{2 E I} \qquad (7)$$

which is the well known value.

Again, let it be desired to find the slope at the end when a couple with moment M_o is applied at the end:

$M_s = -M_o$

$M_r = -1$

$$\text{therefore } \alpha = \frac{M_o l}{E I} \qquad (8)$$

This result is obtained with equal (but no greater) ease by the moment area method.

Case II.—The Slope at the Ends of a Simple Beam Supported at Both Ends.—(a) With a single concentrated load (Fig. 2):

Let it be desired to obtain the slope (α) at the right end of the beam of constant section shown in Fig. 2, which also shows the moment curve for M_s.

Then, (load) $M_s = \frac{Px(l-a)}{l}$ from left abutment to P,

$M_s = \frac{Pa(l-x)}{l}$ from right abutment to P, $M_r = \frac{x}{l}$.

$$\text{Then } \alpha = \frac{1}{EI}\int_0^a \frac{P(l-a)}{l} \cdot x\, d x \cdot \frac{x}{l} + \frac{1}{EI}\int_a^l \frac{P a (l-x)\, x\, d x}{l^2} = \frac{Pa}{6 E I l}(l^2 - a^2) \qquad (9)$$

in the direction shown, that is downward to the left. This is the simplest method of obtaining this result.

The slope at the load (α_1) may be obtained easily by this method by applying M = 1 at the load, thus (Fig. 3):

$M_s = \frac{Px(l-a)}{l}$ from left abutment to load;

$M_s = \frac{Pax_1}{l}$ from right abutment to load;

$M_r = \frac{x}{l}$ from left abutment to load;

$M_r = -\frac{x_1}{l}$ from right abutment to load.

$$\alpha_1 = \frac{1}{EI}\int_0^a \frac{P x^2 (l-a)\, d x}{l^2} - \frac{1}{EI}\int_0^{l-a} \frac{P a x_1^2\, d x}{l^2} = \frac{P a (l-a)(2a-l)}{3 E I l}$$

This is a negative quantity, showing that at the load the axis slopes in a contrary direction to that indicated by the

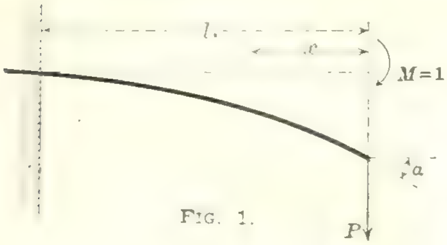

FIG. 1.

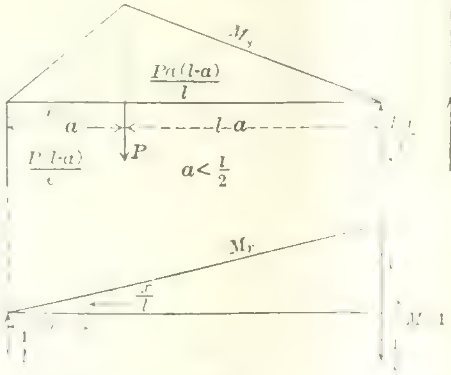

FIG. 2.

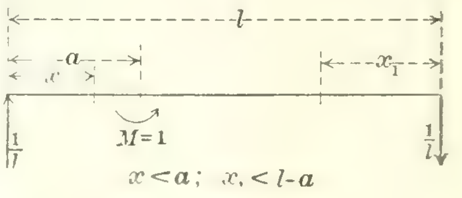

FIG. 3.

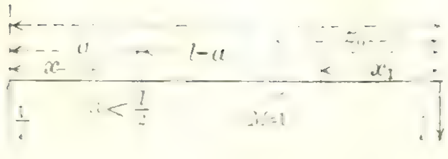

FIG. 4.

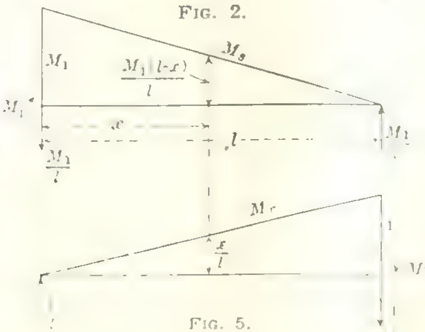

FIG. 5.

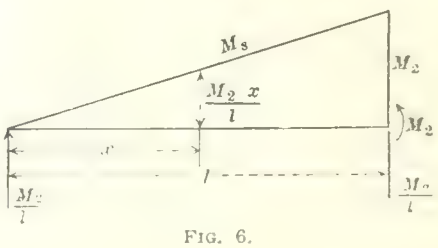

FIG. 6.

applied moment [illegible] that is [illegible] slopes downward to the [illegible].

The point where the axis is horizontal may be easily found by this method. Let this point be distant z from the right end (that is, in the longer segment) and let a moment M = 1, be applied here. The slope there being zero, find $a_0 = 0$, as follows:

The values of M_s and M_r will be as follows (Fig. 4):

Between left end and load: $M_s = \frac{P x (l - a)}{l}$ [illegible]

$$M_r = -\frac{x}{l}.$$

Between right end and [illegible]: $M_s = \frac{P a x_1}{l}$

$$M_r = \frac{x_1}{l}$$ [illegible]

Between z and load: $M_s = \frac{P a x_1}{l}$

$$M_r = -\frac{x_1}{l} + 1.$$

$$E I a_0 = 0 = \int \frac{P x (l - a)}{l} [illegible] d x [illegible] \int \frac{P a x_1}{l} [illegible]$$

$$\int \frac{P a x_1}{[illegible]} [illegible] + \int \frac{P a x_1}{l} [illegible] [illegible]$$

(b)—To find slope at the right end due to a moment, M, at the left end, causing compression in the top fibers (Fig. 5):

$$M_s = \frac{M (l - x)}{l}, \quad M_r = \frac{x}{l}$$

$$a = \int \frac{M_1 x (l - x) d x}{l^2 E I} = \frac{M_1 l}{6 E I} \quad \dots \quad (1)$$

Acting in the direction of the moment, M = 1, or downward to the left.

(c).—To find the slope at the right end due to a moment, M_1, at the right end, causing compression in the top fibers (Fig. 6):

$$M_s = \frac{M_1 x}{l}, \quad M_r = \frac{x}{l} \text{ as before}$$

$$a = \int \frac{M_1 x^2 d x}{l^2 E I} = \frac{M_1 l}{3 E I} \quad \dots \quad (2)$$

downward to the left.

The remaining cases to which Professor Swain makes an application of his principle are as follows:

Case III.—The Continuous Girder.—Theorem of Three Moments.

Case IV.—Slope (a) at the Foot of One Post of a Rigid Rectangular Bent Supported on Pins, and One Pin on Rollers.

Case V.—A King Post Truss.—Angular rotation of a joint.

Case VI.—A Framed Bent with Columns Rigidly Fixed at the Bottom.

Case VII.—The Arch Without Hinges.

Case VIII.—Second Stresses.

Nowhere in Professor Swain's article does he claim that his principle will give a solution to any problem in structures which cannot be found by other methods. He states that his principle is the simplest method for obtaining the result in Case II. We question whether this statement can be justified, for by the well known area moment method

$$a = \frac{1}{E I l} \times \text{moment of the M diagram about the [illegible]}$$

end, or

$$a = \frac{1}{E I l} [illegible] \frac{P a (l - a)}{l} [illegible]$$

$$\left(a + \frac{l - a}{2} [illegible] \right)$$

$$= \frac{P a (l - a) (l + a)}{[illegible] E I l} = \frac{P a}{6 E I l} [illegible]$$

Points Requiring Special Observation and Investigation in Bridge Inspection*

[illegible]

The old proverb that a chain is no stronger than its weakest link seems sometimes to be contradicted by a bridge truss, which may be stronger than its weakest member appears to be, as judged by the ordinary methods. Professor Vose used to say that there are many bridges that are kept from falling "only by the grace of God and the force of habit." There are certainly many which depend upon some means of transmission of loads to the abutments that no self-respecting engineer would rely upon in designing, though recognizing and taking advantage of it sometimes in a critical investigation of an existing bridge. For instance, a rapidly moving electric car may skate safely across a short span or a single panel which would be unsafe for the same car even to stand on. Another example is found in the fact that a bridge may be safe for a car electrically driven when it would be unsafe for a steam locomotive of the same weight, on account of the difference in the mode of transmission of the power to the driving wheels, rotary in the one case and reciprocal in the other. These are cases which show a reduction of strain on stringers often greater than would be the increase of strain due to [illegible] [illegible] load. Track rails [illegible] [illegible] materially to the carrying power of stringers of short spans, especially if the rails are heavy. Guard rails and even guard timbers and the stiffness of the car itself give some help; also the continuity of the stringers of a truss bridge when the stringers are framed into the floorbeams and riveted to them. The stiffness of truss chords may make the strength decidedly greater than would be determined by considering each intersection as if it were a joint with a fractionless pin, instead of a continuous riveted box girder, as may be the case.

Rivets and Pins. A very marked instance of greater strength than is assumed in the ordinary methods of calculation is the case of rivets and pins. A large factor (indeed probably the main factor) in the real strength of a riveted joint is the friction of the members upon each other under the pressure of the gripping of the rivet. W. J. Watson, in a paper presented to the American Society of Civil Engineers on [illegible] of cross section of rivet for one plane of contact (or when acting in single shear) and 18,000 lb. per sq. in. for two planes of contact (or in double shear). The present author would hesitate to give definite mathematical value to this friction, since probably no two rivets exert the same pressure. But it is axiomatic that this friction is great only while the rivet is tight; as soon as the rivet becomes loose it is an entirely different story. This value of a riveted joint is so great and so evident that account of it is taken in the author's modifications of the specifications of the Massachusetts Public Service Commission. In calculating pins it is customary to assume that the pressure of each member upon the pin is concentrated at the center line of its bearing surface, whereas the fact is [illegible] would fail by bending, the pressure of each member would become concentrated at that edge of the member which would give the minimum bending moment. This makes the real bending moment on most pins only a small fraction of that obtained by using the ordinary assumptions. An examination made by sawing through the line of flange rivets of an iron floorbeam removed [illegible] exceptionally good condition, though by the accepted method of calculation [illegible] bridge, pins which were figured to have a [illegible]

Secondary Stresses Due to Large Gusset Plates. [illegible] matter the importance of which is often greatly overestimated [illegible] at joints of rivet [illegible] engineers speak with awe of the "terrible secondary stresses," [illegible] stiffening them throughout the length of their panels thereby reducing the unsupported length of the members and also giving them [illegible]. This remark should not be understood to advise rigid eccentric connections, for these should always be avoided if practicable and the eccentricity reduced to a minimum when it cannot be altogether avoided. It is simply intended to call attention to a side of the question which is sometimes overlooked. If one were to judge by the [illegible] or the "secondary stress" bugaboo, pin connected trusses would be the ideal construction for all bridges. [illegible] the greater rigidity of still [illegible] make them far more durable especially for moderate and short spans; while plate girders, for a similar reason, are still better for lengths for which their use is practicable.

The importance of rigidity and reduction of vibration, not only in prolonging the life of a bridge but also in increasing its strength when new, can hardly be overestimated. Its advantage in increasing the confidence of the public is also real and important. Time was when some engineers delighted in pointing out the "spidery" structures of their designing, with pride that they could perform such marvels. The cost, or amount of material used in such cases may have exceeded what would have sufficed for a structure that would appear and really be, much more substantial.

Effect of Position of Track on Bridge Capacity.—The capacity of a bridge for track loads is far more affected by the position of the track than is generally appreciated. It is frequently found that a track which, according to the plans, should be centered with the bridge is considerably off center. As an illustration of the effect of this "eccentricity," take the case of stringers 5 ft. on centers, and the center of the track 1 in. to one side of the center of stringers; this causes a strain on the nearer stringer 3⅓ per cent greater than if the track were on center. The eccentricity of a track is likely to change from time to time, especially on a curve and particularly near its ends. Because of possible changes in the eccentricity it is the practice of the author, in making up the figures for moment and shear, for inspection reports, to make them first, as if the track were on center and to make a separate item for the excess due to eccentricity of more than about ½ in.

Increase in Shear Due to Sidewalks.—An overhanging sidewalk, similarly, adds more than its weight and that of its load to the strain on the nearer truss. Reduction of moments in floorbeams by such overhanging sidewalks is disregarded in the author's calculations, on account of the possible temporary removal of the sidewalk. But the increase in shear due to such sidewalk is given its due importance.

Impact Allowance with Roadway and Sidewalk Loads.—Sometimes engineers are known to argue that no impact allowance need be made with roadway and sidewalk loads, though it seems strange that anyone should hold this opinion. The specified 100 lb. per square foot is no doubt sufficient to provide for as large a crowd on a sidewalk as can move with such speed and harmoney as to exert the additional force ordinarliy included in the term "impact," unless the gathered crowd is expected to "cheer with its feet." But even for sidewalk loads there is a possibility of a greater weight than the sum of the specified weight and the specified impact. Prof. L. J Johnson, in experiments made in 1904, obtained a weight of 181 lb. per square foot. In reporting the experiments to the Boston Society of Civil Engineers, Prof. Johnson says: "Though 181 lb. per square foot must be conceded to be an extreme, it is believed that something very close to that figure is reached, over the whole drawbridge on the way from Soldiers' Field to Harvard Square after one of the great football games"; and he adds, "The conclusion seems irresistible that loads of 180 lb. per square foot may actually occur in exceptional cases; that 160 lb. must frequently occur; that 140 lb. must be common on station platforms, in corridors and in many other places frequented by throngs of people." In the present day of rapid giant automobile trucks, the case for roadway loads is different. One such motor truck for which data are available has a weight of 17 tons on an over all area of 140 sq. ft., or 243 lb. per square foot, when carrying no more load than its rated capacity. As there is no inspector at the junction points of highways, it is altogether probable that the overload on such trucks is not kept down to the 10 per cent common with freight cars, and the actual load may be expected to run up sometimes to 300 lb. per square foot of the space occupied when the truck is at rest. (Trucks with much greater weights per square foot than this are operated in this city but they are reported as never used on bridges.) Of course the whole roadway of a bridge would not be covered with such trucks in close contact both longitudinally and transversely; and if they were so placed, they would not be able to operate at speed. But such loads covering a third of the roadway area would be quite possible and might run at moderate speed. That the specified allowance for impact is none too large for such loads any observing man will admit after seeing and hearing such trucks run across a bridge with a plank floor, or one on which even small pebbles are found.

Errors of Erection.—If errors in erection have been found, so that members are transposed or misplaced on the pins, or if a test with the hammer indicates uneven distribution of stress between the pairs or sets of tension members intended to work together, due attention must be given to these facts in determining the capacity of the bridge.

Composite Stringers.—Composite stringers, as two or more timbers or beams of different depth, or flitched beams with timber between I-beams or channels, present two possible conditions to the investigator. If the component parts are constrained to equal deflection, the load is considered as distributed in the way which would cause such equal deflection, in which case the capacity of the combination is less than the sum of capacities of the components. If unequal deflections may take place, the distribution of the load is determined by the theory of least work, or so as to produce equal unit stresses in the extreme fibers, if of similar material, or proper relative stresses if of unlike material.

Provision for Safety of Derailed Cars.—Any type of construction which makes no provision for the safety of a derailed car is very undesirable. One such which seems to be popular is a flitched beam with the rail spiked directly to the timber stringer, which is bolted between two I-beams or channels, with no floor between the stringers at all adequate to support a car if it leaves the rail. Another similar construction is a double stringer of I-beams or channels with spiking pieces between, which rest on horizontal separators of short pieces of channel riveted to the beams. Fortunately, many bridges with such stringers have heavy plank floors laid on top of the stringers, so providing for the safe passage of a derailed car if it does not get too far away from the track stringers. A danger in many highway bridges is that a car may leave the rails and the support provided for it and get on to that part of the bridge where the stringers were designed for lighter loads; perhaps also nearer the center of floorbeams competent to carry a car only near one end.

Investigation of Compression Members.—Compression members should sometimes be investigated on three different bases, each with its proper length and radius of gyration:

(a) In the plane of the truss.

(b) In the plane of the members, perpendicular to the plane of the truss.

(c) In a plane normal to the least radius of gyration of the member or of one of its components.

In case (a) the effective length may be taken as the distance between centers of connections (or sometimes less) instead of the distance between the theoretical panel points.

Pony trusses without proper side support for the top chords call for careful consideration as to what should be taken as the unsupported length of such chords. No general rule for such cases can be laid down but each must be considered on its own merits, according to the specific conditions.

Riveted Connections.—The value of a rivet whose grip is more than four diameters is decreased about 1 per cent for each 1/16 in. of this excess. Attention may here be called to the fact that the diameter of a rivet which fills the hole is 1/16 in. greater than its diameter before driving.

Rivets in reamed holes if equally well driven are worth much more than in punched holes for several reasons:

(a) Because in the reamed hole the rivet upsets more readily to completely fill the hole;

(b) Because it has its full section for its full length without a possibility of offset or shoulder;

(c) Because, on account of both facts just mentioned, the rivet also exerts greater pressure on the parts riveted together, increasing the friction between the surfaces in contact;

(d) Because whatever burr is formed in reaming the holes adds to the friction between the parts.

The rivets of top flanges of deck girders and stringers, especially in very old bridges, are sometimes found to be insufficient for local loadings.

In riveted connections the spacing is often so close as to leave insufficient metal between to develop the rivets. If this is found to be the case the value of the net section is used, rather than the rivet value, in determining the value of the detail. The same trouble is often found near the ends of a girder, where the desire to save 1/16 in. in the thickness of the web leads the careless or ignorant designer to crowd the rivets unduly. This reduction of thickness of web is in other ways not always real economy, as it may necessitate additional stiffeners costing more than is saved in the web.

Floorbeams. End floorbeams of swing bridges or of fixed spans adjacent to such bridges are often found to be lighter than the intermediate floorbeams, through a mistaken notion that the loads for these floorbeams are only half as great. As a matter of fact, the actual live load is usually much larger (often double or even more), and even the dead load is sometimes greater than on the intermediate floorbeams, for the overhang of the floor gives not only an extra loaded length, but also a leverage which makes the force acting on the floorbeam greater than the weight of the load itself. In addition to the direct loads, the extra impact due to the open space between the fixed and movable spans adds greatly to the effect of the live load, which is still further increased by a possible difference in level of the floors of the two spans.

Pedestals and Rockers.—Often pedestals for truss bridges, and sometimes rockers for long plate girders, are found to be too short to provide fully for longitudinal thrust, or webs are too thin to support their loads and resist transverse shocks without stiffening diaphragms. In a similar way pin plates on compression members of pin trusses, or joint gussets of riveted trusses, are frequently found to be too thin to give a radius of gyration for the unsupported length of jaws comparable to the radius of gyration of the member as a whole for the whole length of the member.

Loop Hangers.—Loop hangers for floorbeams are frequently found to be deficient in the details. Loop hangers of liberal size may bear upon clip angles which have insufficient strength, either in themselves or by stiffeners bearing upon them, to prevent bending up from the weight which they have to carry. Sometimes insufficient rivets are used in connecting such clip angles to the floorbeams. Even when a loop hanger passes down through or around both flanges of a floorbeam and takes bearing on the bottom flange angles, if there is no tie plate or only a thin loose washer plate, these angles and washers are very often found to be insufficient.

Decay of Timber Stringers.—The reduction of the strength of timber stringers due to decay is not always appreciated. That the unit stresses generally allowed for timber leave a larger factor of safety above the elastic limit than is commonly left in the case of steel members is realized. This is wise, because wood exposed as is usual on bridges deteriorates more rapidly than steel or iron which receives reasonable care. But, regardless of the reduction of strength of individual fibers which, though not so far gone as to be called rotten, are approaching that stage, a slight loss of section in the top or bottom of a stringer reduces the strength for resistance to bending altogether out of proportion to the amount of section lost. In a timber beam 12 in. deep a loss of

1 in. in depth reduces the section 8 per cent and the strength 16 per cent.
2 in. in depth reduces the section 17 per cent and the strength 30 per cent.
3 in. in depth reduces the section 25 per cent and the strength 44 per cent.
4 in. in depth reduces the section 33 per cent and the strength 55 per cent.

If the decay is uneven the loss of strength is even more striking. A 12-in. stringer having full depth at one side and reduced at the other side

2 in. has its section reduced 8 per cent and the strength reduced 28 per cent.
4 in. has its section reduced 17 per cent and the strength reduced 46 per cent.
6 in. has its section reduced 25 per cent and the strength reduced 58 per cent.
8 in. has its section reduced 33 per cent and the strength reduced 66 per cent.

Sound timber, notched for pipes or other obstructions, would be reduced by these ratios; but in considering decayed timber it must be remembered that there is not a sharp dividing line between sound and rotten wood. Hence it is not wise to increase the allowed unit stress in timber for the consideration of existing structures above the amounts given in the specifications, particularly as decay in timber is wont to proceed rapidly when once started. Oak, chestnut, ash, and, to a less degree, spruce timber may lose a great part of their original strength while still showing little change in their appearance, as previously more fully explained in connection with remarks on inspection.

Reduction of Strength by Corrosion and Bolt Holes.—Corrosion and bolt holes in flanges of rolled steel beams reduce the strength far more than is generally realized. Of course the fact is known when thought of, but it is too commonly overlooked. The following figures illustrate these cases:

If a 12-in.-31½-in. I-beam used as a stringer has
1 hole ⅞ in. in diameter in one flange, the strength is reduced 12¼ per cent,
1 hole ⅞ in. in diameter in each flange, the strength is reduced 14¼ per cent,
holes ⅞ in. in diameter in one flange, the strength is reduced 24½ per cent,
2 holes ⅞ in. in diameter in each flange, the strength is reduced 28½ per cent,
⅛ in. thickness rusted from one flange, the strength is reduced 15¼ per cent,
⅛ in. thickness rusted from each flange, the strength is reduced 19 per cent.

If a 12-in.-20½-in.-lb. channel used as a stringer has
1 hole ⅞ in. in diameter in one flange, the strength is reduced 17¾ per cent,
1 hole ⅞ in. in diameter in each flange, the strength is reduced 21½ per cent,
⅛ in. thickness rusted from one flange, the strength is reduced 15 per cent,
⅛ in. thickness rusted from each flange, the strength is reduced 18¾ per cent.

Spacing of Ties.—Ties should be spaced not more than 8 in. apart in the clear (6 in. is better), or a derailed car wheel will drop so low between the ties as to cause too great pounding. They should be notched not less than ¾ in. for the stringers and attached to them by hook-bolts or some suitable substitute at every third tie. There should be not less than 6 in. thickness of timber above the dapping. For wide spacing of girders or stringers, or when one rail is elevated while the stringers are at the same level, deeper ties may be required. The case of burning of stringers by a short circuit cited above illustrates the importance of ample depth of ties above the dapping.

Guard Rails. Inside guard rails are a very important adjunct to a bridge carrying a track, to prevent the wandering of a derailed car; such guard rails should be fully spliced or their efficiency will be greatly reduced. Care should be taken that bolts are so placed that neither heads nor nuts can be sheared off by a derailed car. Some engineers do not realize that outside guard timbers do not answer the same purpose; and the requirements of at least one Railroad Commission until recently called for lining angles on these timbers, apparently with this misunderstanding. A brief consideration of this subject will show the fallacy of this [illegible] if a wheel is retarded by rubbing against the inside rail, it will tend to turn the axle a little, directing the car toward it. [illegible] the [illegible] of [illegible] rubbing on the outside guard timber will swing it further out of line and away from its proper place. This change of direction, too, will throw it against the guard more nearly at right angles, thus making it more likely to climb the guard and leap into whatever disaster is lurking beyond.

Though the outside guard timbers are not qualified for guiding a derailed car, they do have a very important office. Without them or some substitute, the ties would be likely to become bunched; the guard timbers also help to distribute the load and reduce the danger that the ties will tip up under a derailed wheel when stringers are too closely spaced. Guard timbers should always be notched over the ties and should be bolted to at least every fourth tie. Splices should have a horizontal lap joint.

General Principles of Industrial Lighting

Good lighting is an investment. In a plant which is properly illuminated accidents are less frequent, the employees work more efficiently and make fewer mistakes, a closer and better supervision of the men is possible, and the employees are contented and more stable in employment because of the orderly and pleasant surroundings resulting from good lighting. An interesting discussion of the features to be aimed at in an industrial lighting system is given in a "Safe Practices" Bulletin issued recently by the National Safety Council. The matter following is abstracted from this bulletin:

Illumination Intensity.—Illumination intensity is expressed in foot-candles. One foot-candle is the intensity of illumination produced on a surface one foot distant from a lamp of one candle power, the surface being at a right angle to the light rays.

Different industries, and different operations in the same industry, require varying intensities of illumination. The useful light is that which is reflected from the object viewed. The brightness of the object then is the vital factor, and this depends not only on the light received, but upon the reflecting power of the object. Materials vary greatly in reflective power; white surfaces reflect as high as 80 per cent of the light, while black surfaces reflect less than 5 per cent. It is, therefore, important to consider the average reflecting power of the materials worked upon, as well as the nature of the work, whether rough or fine.

Recommended Intensity at the Work.—Table I is in line with the recommendations of state labor departments and the Illuminating Engineering Society. The lower intensities given are considered sufficient for safety, but the higher values are recommended from the standpoint of efficient production. Some authorities, however, consider that still higher intensities are necessary to secure maximum efficiency. War-time experience has brought about a marked trend toward higher standards of illumination.

TABLE I.—RECOMMENDED INTENSITY AT THE WORK IN FOOT-CANDLES.

	Foot-candles.
Roadways and yard thoroughfares	1/10 to ¼
Storage spaces	½ to 1
Stairways, passageways, aisles	1 to 2
Toilets, washrooms	1½ to 3
Rough manufacturing, such as rough machining, rough assembling, rough bench work, foundry floor work	2 to 4
Rough manufacturing involving closer discrimination of detail	3 to 6
Fine manufacturing, such as fine lathe work, pattern and tool making, light-colored textiles	4 to 8
Special cases of fine work, such as watchmaking, engraving, dark-colored textiles	10 to 15
Office work, such as accounting, typewriting, etc.	4 to 8

Consideration in Designing the Lighting System.—After determining the intensity required, the items to be considered in designing the lighting system are:

(a) At what height shall lamps be mounted?
(b) How far apart shall lamps be spaced?
(c) What size of lamp shall be used?
(d) What kind of reflector or globe shall be used?

Height of Lamps.—Lamps should ordinarily be mounted as high as possible unless the ceiling is very high compared to the width of the room, or unless horizontal beams or belting would interfere with the light distribution, or unless close spacing is necessary. High mounting permits wider spacing of lamps, with equally good distribution of the light, making it possible to use fewer lamps of larger size, which means lower installation and operating costs. In addition, higher mounting means that nearby lamps are less likely to be within the field of vision of the workers and thus cause eye strain.

Spacing of Lamps.—The distance apart that lamps shall be spaced depends upon the character of illumination required. If the work is of an exacting character, close spacings are required to produce the uniform lighting needed, whereas for less exacting purposes wider spacings are permissible. To secure uniform distribution and avoid sharp shadows the spacing must not be too great in proportion to the mounting height.

TABLE II.—DESIRABLE SPACING.

Mounting height.	Fine work.	Rough work.
10 ft.	8 to 10 ft.	10 to 12½ ft.
12 ft.	11 to 14 ft.	14 to 17 ft.
14 ft.	13 to 17 ft.	17 to 21 ft.
16 ft.	16 to 20 ft.	20 to 25 ft.
20 ft.	21 to 26 ft.	26 to 33 ft.
25 ft.	27 to 35 ft.	35 to 43 ft.
32 ft.	35 to 45 ft.	45 to 56 ft.

Lamps should be placed with reference to machines as well as to the building construction, so that each machine and work bench will be well lighted. This will sometimes require a closer spacing than indicated above. In such cases the mounting height should be decreased to maintain the proper ratio between height and spacing. This ratio depends on the type of reflector used.

Size and Spacing of Lamps.—The size and spacing of tungsten lamps, to produce any desired intensity, may be determined from Table III, assuming that efficient reflectors will be used.

Typical Examples.

Ordinary Metal or Woodworking Shop—14-ft. Ceiling.—From Table I we find that an intensity of 4-ft. candles is desirable. The lamps will be mounted immediately below the ceiling, assuming that they can be so located that belting or other obstructions will not interfere seriously with the distribution of the light. No local lighting will be required.

From Table II we find that for a 14-ft. ceiling, and moderately rough work, the spacing should be about 17 ft.

From Table III we find that an intensity of 4 foot candles will be produced by the use of 150 watt lamps (gas-filled tungsten) spaced 15 ft. apart in both directions. The spacing may be varied to suit the location of machines, columns, etc.; for example, the lamps may be spaced 16 ft. apart in one direction and 14 ft. in the other. If the building construction or the machine layout requires a still different spacing, the table shows that 200 watt lamps may be used at an average spacing of 18 ft. or 100 watt lamps at a spacing of 12 ft. —the same intensity being secured in either case. If a 12-ft. spacing is used, the lamps should be lowered to about 12 ft. above the floor.

Tool Making, Pattern Making, Light-Colored Textiles—14-ft. Ceiling.—For work of this class Table I shows that an intensity of 8 foot candles is desirable. This class of work requires closer spacing—13 to 17 ft. (see Table II). From Table III we find that 200 watt gas-filled tungsten lamps may be used with 13-ft. spacing or 300 watt lamps with 17-ft. spacing depending on the arrangement of machines, columns, etc.

Warehouse or Storage Space with 12-ft. Ceiling.—By reference to the tables already mentioned, we find that an intensity of one foot candle is recommended, and that 50 watt vacuum tungsten lamps, at an average spacing of 14 ft., will be sufficient, or 75 watt gas-filled tungsten lamps may be used at 19-ft. spacing. The lamps should be placed near the ceiling and located to give the best light for aisles. Shallow-bowl reflectors should be used because of the comparatively wide spacing in proportion to the ceiling height.

Foundry.—The intensity desired at the work is about 4 foot candles. To allow for loss of light on account of smoke and

TABLE III.—SIZE OF LAMPS AND SPACING REQUIRED FOR VARIOUS INTENSITIES OF ILLUMINATION

L = Lamp size in watts. S = Spacing in feet.

(These values do not apply to indirect lighting.)

Foot-candles.	Vacuum tungsten.	Gas filled tungsten.								
	L S	L S	L S	L S	L S	L S	L S	L S	L S	L S
¼	50—28		100—48	150—61	200—[illegible]					
½	50—20	75—27	100—34	150—43	200—[illegible]	[illegible]				
1	50—14	75—19	100—24	150—31	200—[illegible]	[illegible]	400—55	500—63		
2	50—10	75—14	100—17	150—22	200—[illegible]	[illegible]	400—39	500—45	750—56	1,000—
3	50—8	75—11	100—14	150—18	200—[illegible]	[illegible]	400—32	500—36	750—46	1,000—54
4		75—10	100—12	150—15	200—18	[illegible]	400—28	500—32	750—40	1,000—47
5			100—11	150—14	200—[illegible]	300—21	400—25	500—28	750—36	1,000—42
6			100—10	150—12½	200—[illegible]	300—19	400—23	500—26	750—33	1,000—38
8				150—11	200—13	300—17	400—20	500—22	750—28	1,000—33
10					200—[illegible]	300—15	400—18	500—20	750—25	1,000—30
12						300—13½	400—16	500—18	750—23	1,000—27
15						300—12	400—14	500—16	750—20	1,000—24

dust, the lighting should be designed for a theoretical intensity of 6 foot candles. The mounting height is ordinarily determined by the crane and the size of lamp will be determined by the height being approximately as follows:

20 ft	[illegible] watt
[illegible] ft	[illegible] watt
[illegible] ft	[illegible] watt
[illegible] ft	[illegible] watt
40 ft	[illegible] watt
[illegible] 40 ft	[illegible] watt

The spacing is then found from Table III. It may be necessary to vary the lamp size slightly to secure a spacing which will conform to the building construction and at the same time secure the desired intensity. Deep-bowl reflectors are generally used. Angle type reflectors are desired where placed along walls below crane runway.

Lighting Suggestions.

Yards. For yard lighting the lamps should be mounted [illegible] ft or more above the ground. Shallow bowl reflectors may well be used. The spacing between the units should not exceed four times the mounting height, unless prismatic refractor units are used. The prismatic refractors provide better eye protection and permit wider spacing. Several plants have found the following standard satisfactory, corresponding to an intensity of about one-third foot candle:

Area illuminated by one lamp.	Size of lamp
2,000 sq. ft.	100 watt
3,000 sq. ft.	150 watt
4,000 sq. ft.	200 watt
6,000 sq. ft.	300 watt
8,000 sq. ft.	400 watt
[illegible] sq. ft.	500 watt

Where lamps must be supported from a building wall use a bracket pipe fixture extending about 4 ft. 6 in. from wall.

Flood lighting has been found effective for illuminating yards and storage areas. For locations difficult to reach with wiring, the light may be projected to a distance of 100 to 1,000 ft. Projectors may be installed on the roofs of buildings, and poles eliminated.

Stairways.—A 50-watt tungsten lamp mounted as high as possible at the head of each flight of stairs will give good results. A deep-bowl reflector should be used, arranged to throw the light down the stairs.

Individual Lights.—Where local lighting is necessary tungsten lamps of 15, 25 or 50 watts are used, depending upon the exactness of the work and the color of the material worked on. Each lamp should be equipped with a reflector to protect the eyes of the workman and to throw the light on the work. On some machines it may be necessary to install an adjustable lamp fixture, which will enable the operator to direct the light to the exact position desired. The use of rigid fixtures is usually preferable and reduces lamp breakage.

Benches: Lamps are frequently located about 18 in. above work table, with bottom of reflector about on a level with workman's eyes; a 25-watt lamp is generally sufficient. Another method which gives a better distribution calls for lamps from 6 to 10 ft. apart, from 50 to 100 watts in size, preferably placed between workmen so each work-place is lighted from two sides.

Drafting Tables: For drafting rooms, indirect lighting is generally preferred. Where this is impracticable, each drafting table should be equipped with two 50-watt frosted lamps, mounted about 42 in. above the table, so that each lamp illuminates one-half the table and shadows are minimized.

Sewing Machines: Unless an efficient system of indirect lighting is employed, local lamps are necessary at each sewing machine. For light materials a 15-watt lamp is satisfactory, for dark materials a 25-watt lamp is advisable.

Frosted Lamps: Material with a highly polished surface will reflect the bright image of a clear lamp and cause glare in the workmen's eyes. To avoid this, frosted lamps should be used for such work or an opal cap should be provided.

Drop-cords: The use of drop-cords should generally be avoided, and wherever local lamps are needed they should be installed in a permanent rigid fixture. If drop-cords are used, they should hang vertically, and not be pulled to one side and hooked over a nail or machine part. If the light is not in the proper position, the socket should be changed by an electrician. For vertical adjustment, a block should be provided. Drop-cords should be well insulated, and [illegible] proofed if used in a damp location.

Extension Cords: Where portable lights must be used, the cords should be heavily reinforced to prevent [illegible] short circuiting.

Duties of the Engineer, His Past Accomplishments, and the Outlook for the Future

By FAYETTE S. CURTIS

[illegible]

It is quite probable that [illegible] the question [illegible] profession [illegible] tive answer has been given. The civil engineer, when thoroughly fitted for his profession, immediately becomes useful [illegible] and the [illegible] world-wide influence.

His duty consists in designing, arranging, and building structures or machines which require the immediate superintendence of those who are [illegible] principles but the practice of construction; for engineering is a branch of knowledge that takes its place both among the sciences and the arts.

Therefore, to be eminent in his profession, or any branch of it, he should be able, not only to design and plan, but to supervise construction. Those who have only the knowledge of how to design and plan [illegible] become confused in meeting the [illegible] arise.

Scientific and Practical Education.—The profession, embracing as it does almost every kind of construction, requires a very extensive and general acquaintance with other sciences, in order that the engineer may be qualified to accomplish successfully the various works on which he may be engaged, and to overcome those difficulties which frequently arise unexpectedly in the progress of his work, and, but for that knowledge and talent, threaten its final success.

Thomas Telford, in his "Descriptive Narrative of His Professional Labours," has said:

"How can a man give judicious directions unless he possesses personal knowledge of the details requisite to effect his ultimate purpose in the best and cheapest manner? It has happened to me more than once, when taking opportunities of being useful to a young man of merit, that I have experienced opposition in taking him from his books and drawings, and placing a mallet, chisel or trowel in his hand, till, rendered confident by the solid knowledge which experience only can bestow, he was qualified to insist on the due performance of workmanship, and to judge of merit in the lower as well as the higher departments of a profession in which no kind or degree of practical knowledge is superfluous. For this reason I ever congratulate myself upon the circumstances which compelled me to begin by working with my own hands, and thus to acquire early experience of the habits and feelings of workmen; it being equally important to the civil engineer, as to naval or military commanders, to have passed through all the grades of their profession."

It is no doubt [illegible] nence in their profession by individual effort—practicing and studying at the same time, with a view to acquiring a full knowledge of all necessary scientific principles. Students are required to spend a certain time in acquiring technical knowledge, but must not then think they are engineers in the broad meaning of the term, capable of constructing and [illegible] that is a false idea.

No one can doubt [illegible] to the old-time arts course has greatly enriched it, and the sciences are now undoubtedly the most important part of a liberal education; but there is another side, which we cannot ignore, and that is, that after all, the great object of a good education is not so much the accumulation of knowledge as the development of mental power in the individual.

The tendency toward scientific and practical education is no new thing. Men have come to see that the first mental [illegible] by solving physical problems than by studying the [illegible] much true value can be obtained in the study of nature as in

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[illegible]

the spirit of such enterprises as nature. First knowledge is more satisfactory to the best of minds.

Specialization Desirable.—The profession has become so diversified that, after having secured a good fundamental training, it would be worth serious consideration to take up a single branch of engineering practice, as it can hardly be expected that the civil engineer will become proficient in every branch. He would be better able to give his best endeavors to attaining highest proficiency in some particular line and at the same time grasp or understand in a general way the subjects which may relate to the several kinds of work, as the whole subject is so broad that it would be vain to attempt to understand them all in all their details.

Ambition to obtain as great a knowledge as possible is to be admired and encouraged, but to attain the highest standard in one branch is more commendable than to attempt to reach special eminence in all, as the student will be apt to find himself oppressed with a weight which he is not capable of sustaining, and this will be very likely to result in utter failure.

The professional man should not make the mistake of thinking that he can reach the top in an unconcerned and idle manner, believing that by some easy process he will reach and hold it. The structure on which he stands must be constructed by piece and parcel, every member thoroughly tested by a gradual and difficult process; he must experience all the difficulties, trials, and troubles to be met on the way, in order to support and sustain him at the higher elevation to which he aspires. To such the doors to success are open. Work seeks the best hands, as naturally as water runs down hill, but seldom seeks one whose only recommendation is that he needs it. If he is not willing to go slowly through the maturing process of time, through patient work, by steady application step by step preparing himself for the work ahead, which has made men prominent and efficient in their profession, then, alas, the result is doubtful. It is like the student who prepares his education for future advancement. He goes from grade to grade until he is master of the science on which he has to build, taking no upward step until the last has been tested and found not wanting in any characteristic which will sustain him and serve him to build on for the future.

New Problems Are Constantly Arising.—The tremendous growth of our complex industrialism means the facing of new conditions, that we may overcome new difficulties and enjoy new benefits. Therefore, there is only work to face, and it should be met with a spirit characteristic of the creator of science, and thereby much may be accomplished.

There is no success without hard and earnest labor. Never balk at a few obstacles, but hang on with all your might; this, in the end, will give success. It is true that many experiments will have to be made, but there can be no doubt of ultimate success if our aim is a determination to succeed and we do not become discouraged.

As we look back, even over a short time, how often have we said to ourselves, after completing some important structure, "This should last for many years—we have reached the limit;" but within a comparatively brief period have we not seen that structure replaced by another, larger and more expensive, which has been demanded by the growth of business? We have not stopped building, nor have we come to the time when we have built sufficiently for the future, and we never will, as long as the richness of this country is undeveloped and its physical and financial growth continues. To stop this great advancement, which the people continue to make, would be death. Then, does it look as though there was not a future for the engineer who has integrity and perseverance, as he is and must be the practical foundation or basis for all which we are to build, in order to accomplish a higher and nobler position in society?

The Engineer Prime Factor in Growth of Country.—The work of the engineer is the foundation on which rests the growth of this great Republic, not only physically but financially. He is one of the prime factors, and could not by any possibility be dispensed with. We are not an organization which threatens to pull down and wreck or destroy what we have built, but an educational organization, and hope to get the necessary recognition of our rights through education. No doubt the engineer has often had his line of procedure curtailed by some power having authority to suspend or discharge at will, at the pleasure of some controlling power, ignorant and with no understanding of the conditions or the difficulties the engineer may have to meet, and without the least knowledge of engineering subjects.

Civil engineering is ages old, but has always shown a steady progression, possibly not as to more substantial work, but certainly in the facilities provided in machinery to do its work. As to its beginning, I will not undertake to say, but will only refer back to those times of which we may have knowledge, and ask if the great work done is not a credit to the scientific ability of this profession? But what is the future to be? Does it depend on those who are coming into this society—educated, experienced—to show to the world that they can and will continue to build and improve the financial and social conditions? For a determination we must wait on time.

Benefits of the Society to the Engineer.—Is the engineer being benefited by his connection with this society? It has been said that the society is becoming less democratic and more conventional, or, in other words, is not taking sufficient interest in, or having proper regard for, its members, and, therefore, they are without the opportunities or advantages which they might gain in local societies. This society has grown to such an extent that contact personally with all its members is not possible, but the interest and devotion and brotherly love of its members are just as great as ever. The information in the different papers by the most prominent engineers of the country, presented and distributed, is of the greatest importance to the members of the society. As the soicety grows, this information increases, and the papers are more numerous and contain information and knowledge which cannot be obtained except through the parent society. If not, why are so many engineers anxious to affiliate themselves with this society? They know it gives them prestige the world over, and sets a standard which has been passed upon and approved by the highest of professional men. Our constitution requires that standard to be higher than that of any of the local societies.

The society has not only grown in numbers, the increase within the last ten years being 85 per cent, but has increased in influence in the estimation of the public and the world at large; our members are looked up to as the leaders in the engineering profession. Then, who can say that it, as an engineering society, has depreciated, gone back, or fallen off one iota from its former standing? On the contrary, it has grown steadily stronger and stronger. Its members have become of such strength, in the material and financial upbuilding of the Government, that they are indispensable.

Therefore, we must not permit ourselves to forget the obligation we owe to the founders of this society, the men who gave their time and talent in creating an organization which has proved to be of untold benefit to the engineering profession. How, then, are we to repay them, if not by giving to the society our support and assistance, promoting good fellowship among its members, encouraging its officers, and giving a helping hand to the future engineer who comes into the society, passes up through the different grades of experience, and is seeking information? Let us all do something in the interest of the society, and thereby broaden its influence and add to its high standards of proficiency.

We certainly cannot help by creating dissensions among the members, or becoming dissatisfied with the earnest labors of those whom we select to bear its responsibilities, or in getting the idea that we are connected with this society wholly for what we can get out of it. No matter how much we give, we can never repay the society for the benefits we have received.

Promises for the Future.—The engineer has designed and built many a monument which will endure for ages as a testimonial to his proficiency and skill. We need not go back many years to find members who have won the highest engineering distinction and whose names are ineffaceably engraved on the enduring pages of history. We know who they are and what they have accomplished. Even before this society was organized, we find the names of engineers who achieved everlasting remembrances through their exceptional ability. Therefore, I would say to engineers, but more particularly to the younger members of the profession, that there is a future for them which, if taken advantage of, will ensure the highest honors possible to be obtained.

By him who is in the prime of life and in the possession of health, strength, and knowledge of the arts and sciences, much may be accomplished. Therefore, never give up.

Think, work and suffer, that in this life you may gain something which will place your name upon the highest pinnacle of fame

Many of our members have been engaged in the late war and their work, in the construction of yards, docks, cantonments, and the reconstruction and building of bridges, roads and equipment, both in this country and on the other side of the Atlantic, thus making it possible to take care of millions of troops, was the most important factor in bringing the war to a successful termination. All of this has been done in such short time as to bring out comment and praise from the whole world. Why should not the engineer have his full due and credit for the ability he has shown, not only at critical moments during the war, but in the accomplishment of things at other times?

We are living in an age in which we possess all the information as to what has been done for many years, all of which we ought to profit by. The conditions change, the opportunities grow greater. This world is growing in its necessities almost beyond the imagination of the present generation. The country is being developed so that every state in the Union is increasing in wealth and prosperity. Greater facilities are needed to accommodate its growth. And yet some say there is no future

Work of Other Engineering Societies or Organizations.—They have all done their part in building and developing the great industries of the world. All are working toward the same purpose, creating, building, and improving the facilities on which the prosperity of the country depends. This is illustrated by the establishment of engineering council, composed at present of representatives of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Society for Testing Materials, for the purpose of giving more strength to the profession and obtaining greater recognition for the engineering arts and sciences.

Why should we not go farther, and even take our position in governmental affairs? Is it the political cloud that casts a shadow over us, so that our practical ability does not get the proper recognition in government affairs; or is it our modest, indifferent way of being satisfied with our present condition? We should rise to the occasion, demand our rights, and a proper recognition by the people generally, with the idea that we are not only to advance the engineering arts and sciences but to fill the positions under this general government which require the knowledge of how to govern, each according to his ability.

The armistice having been signed, it is incumbent on us, as founders of prosperity, with the sciences and the arts, to become one of the greatest upbuilding factors in the future, to help reconstruct that which has been torn down and destroyed by the ravages of war, and to promote new ideas for the world's future prosperity.

Emerging from the greatest war the world has ever known, not only in the number of men engaged and the use of the most deadly weapons, but in the destruction of property, what does this mean for the future? The employment of many engineers to reconstruct, and to rebuild in an improved form.

In the future the names of many of you engineers will be enrolled among those who have attained high public standing through great achievements. Many in our profession have thought, done, and suffered much in former days. Childhood may seem to be at almost an immeasurable distance in the past, but something that we have accomplished on account of its overpowering vastness seems near. It is like a beacon light, far away but seemingly near.

It is said, "The schoolhouse of the world—human experience—however expensive, has something to teach." Shall we learn our lesson readily?

Forty-nine Per Cent of Capacity of Fabricating Shops Contracted For in May.—The records of the Bridge Builders' & Structural Society as collected by its secretary, show that during the month of May, 1919, 49 per cent of the entire capacity of the bridge and structural shops of the country was contracted for.

Opinions of Practicing Engineers on Teaching Economics to Engineering Students

[illegible] representative engineers not engaged in educational work, concerning the teaching of economics to engineering students, the Committee on Economics of the Society for the Promotion of Engineering Education sent a questionnaire to 50 engineers who have been eminently successful in the practice of the profession. The replies of these engineers are summarized in a progress report in the July Bulletin of the Society. The questionnaire was as follows:

Not all of the engineers addressed submitted replies, the percentage of replies being as follows for the different groups: civil engineers 75 per cent, mechanical engineers 80 per cent, architects 60 per cent, electrical engineers 40 per cent, mining engineers 40 per cent.

[illegible]

[illegible] most valuable for an engineer? That is, should it deal with the [illegible] geography.

4. Do you object to having your replies as given quoted?

[illegible] taught in colleges under that caption and refers to the science of wealth. It does not refer to economy of design or construction as [illegible]

The letter accompanying the list of questions stated that no attempt was being made to seek arguments either for or against the teaching of economics, but that frank and unbiased opinions only were being sought.

Group.	No. of replies.	[illegible] aid professional success.	[illegible] acter of course
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible] No opinion 1
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible] special topics 2
[illegible]	[illegible]	[illegible]	[illegible]

With regard to the answers to Question 2, the general purport was that a study of economics would enable the engineer to comprehend more fully the relation of his work to the whole economic fabric of the country. The following quoted replies to this question are fairly definite opinions on this point:

"Would give the engineer a better understanding of the results he is endeavoring to obtain."—Albert F. Reichmann.

"It (economics) gives an engineer a broader field of thought and enables him to solve problems, especially larger projects, etc., in a more logical and better way. An engineer, in order to succeed, must not limit his education to strictly technical [illegible]"—Ralph [illegible]

"The knowledge that would have been gained through a course in economics particularly with regard to such questions as corporation finance and accounting I am sure would have been of great assistance to me in my work, and especially in connection with the reports to the larger corporations and municipalities during the past twenty years." —Bion J. Arnold.

"It (economics) has caused me to comprehend better than otherwise the trade conditions of our country, the import of building materials, the several crises and panics that have occurred in the last 60 years, the wisdom or futility [illegible] considerable [illegible] public works and the estimation of their value and cost [illegible]

"My work requires a sound knowledge of the fundamentals of financial matters, for I am frequently called upon to report upon projects and properties. Engineering is not technique only, but includes a sound treatment of the financial side of all projects. It is even more necessary for an engineer to know whether a development should be made, whether it will pay, than how it should be made."—John Lyle Harrington.

"It (economics) enables one to view a situation broadly, weighing such elements as public policy, labor, transportation, public welfare etc., in a problem which might otherwise be studied from a narrow viewpoint of direct costs only."—H. J. Burt.

"I think such a course would broaden the engineer who was specialized too much in the past."—Hunter McDonald.

"Business principles are as essential to the engineer as mathematics. The broader his education in corporation finance and allied subjects, the better his chance for administrative positions. A large percentage of engineers work for corporations and they should know all about them. I am sure that a good ground work along these lines would be of material help."—E. J. Collins.

"In giving me a basis to which in later years I could revert and analyze the complex relations of capital and labor and the rights of the public."—Bert H. Peck.

"A comprehension of the general laws governing the production and consumption of wealth as well as their application to the specific problems of life enters into the genesis of all successful engineering undertakings. Otherwise, the success of the undertakings depends on luck."—L. E. Imlay.

"As the ultimate object of most engineering work is reduction in the expense of accomplishing some definite process, any training which enables an engineer to thoroughly grasp the relation between the work in hand and its financial results will contribute largely to his profession and success."—Chas. F. Uebelacker.

"A course in economics would undoubtedly have broadened my viewpoint in the earlier work and laid the foundation for clearer thought in the executive position."—Edwin B. Kattel.

"Some knowledge of financing, accounting, securities, business law and business management would have been of assistance."—Charles T. Main.

Mr. Clemens Herschel and Mr. H. L. Gantt do not believe that a course in economics as at present taught would contribute to the successful practice of engineering in any way.

The following are some of the suggestions which a few of the engineers addressed volunteered as to the proper content of a course in economics for engineering students.

Dr. Rudolph Hering says: "Most of the questions of this branch of social science are more difficult to understand than questions of mathematics, physics, geology, etc., because they are much more complex and spread over a larger field and because their practical conclusions must vary with the different stages of development as they are reached by society."

"Of all social sciences, economics is therefore one of the greatest importance. It comes next to ethics, of which it is to some extent a corollary. And all movements to instruct our youth concerning this branch of science are to be most highly commended and furthered."

"I am of the opinion that a competent professor should be able to impart such a course in two semesters at one hour per week."

Mr. Gustav Lindenthal with much the same opinion suggests that economics be taught only in a post-graduate course, since "especially the science of finance requires a very mature mind, certainly more so that [does] higher mathematics or applied science. The present theories are mostly wrong, being based too much upon authority worship and not enough upon scientific analysis, which is considered heretical by banking interests, whose constant efforts are directed towards a higher rate of interest on capital and a lowering of wages instead of the reverse principle."

Mr. H. L. Gantt also is not satisfied with the present tenets and doctrines of economists. He says: "To be perfectly frank with you with regard to the subject of economics, it has been impossible for me to have any patience with the ordinary text-books on economics. They are all written apparently to support certain theories of their authors, and in many cases have but little to do with practical conditions which now obtain.

"In general, books on economics are written from the standpoint of trade and not of production. They were perhaps more or less helpful in the days when trade was the controlling factor in the world. With the rise, however, of modern industrialism, production has become the controlling factor, which throws all previous theories out of gear. The fact that production has become the controlling factor was clearly demonstrated during the war, and is now being demonstrated in Europe. Unless the economics problem is studied and taught from this standpoint, I regard any teaching on the subject as not only of no value, but positively detrimental."

Mr. Leonard Metcalf calls attention to the present urgent need of teaching economics. He says: "It is my personal opinion that the obligations of institutions of learning to the public practically compel the giving of courses in economics at the present time. The present undergraduate bodies in our colleges have had practically no experience or observation in the application of such fundamental laws as that of supply and demand. They have lived since they began to notice such matters in the press and conversation, in a thoroughly abnormal era, with Government control of prices labor and industry. They accept without question as normal the results attained, failing to recognize as older, experienced men do, that these results were possible only with the mind set on one purpose—the winning of the war. They do not recognize that in times of peace, many and probably the majority of men would not tolerate what they accepted willingly, or permit the President and Congress the full measure of power that they willingly gave during the war. Therefore, it seems to me that the most difficult task faced by the institutions of learning the world over is giving the student, in a way that will stick in his memory, a clear picture of the world up to this time and of the operation of well recognized economic laws under normal conditions."

"Unless our institutions of learning and public leaders recognize this and do what they can to broaden the horizon of the student body, there will be tried many economic theories already demonstrated as unsound, an impetus will be given to uncontrolled radicalism and thoughtless socialistic propaganda. There never has been a time probably when there was greater need of open-minded and careful review of old theories than at the present time, but it would be deplorable to lose the crystalized experience of past centuries."

Mr. B. H. Peck outlines somewhat in detail the character of a course in economics that he would consider the most beneficial. "It (the course in economics) should, in my opinion, not be presented by one man, since we all have our peculiar biases and beliefs on subjects of this nature. If I were framing such a course, I would include lectures by financial men who could explain the flow of money to certain fields, and the interest requirements of invested capital; by labor representatives, who could state the attitude of labor and its aims; by an advocate of municipal or Government ownership; by a practical operator of a large enterprise; by a tax commissioner; by a public utility commissioner, etc. Along with these, I would study Smith's 'The Wealth of Nations' or its modern equivalent."

A perusal of the replies reveals a notable lack of uniformity and definiteness of conception on the part of practicing engineers as to the use of the term economics. To some, it apparently applies to the actions of social communities, while to others, it is limited to the details of more or less private business transactions.

The general tenor of the replies is in accord with the report of the committee last year, wherein it was recommended that the formal study of economics consist of a 3-hour outlined course in the general principles of the subject. However, there is a suggestion in a number of the replies that sufficient time should be given to some special topics, such as labor problems, commercial geography, accounting, corporation finance, public finance, etc., to cause the student to appreciate their importance and to grasp their significance.

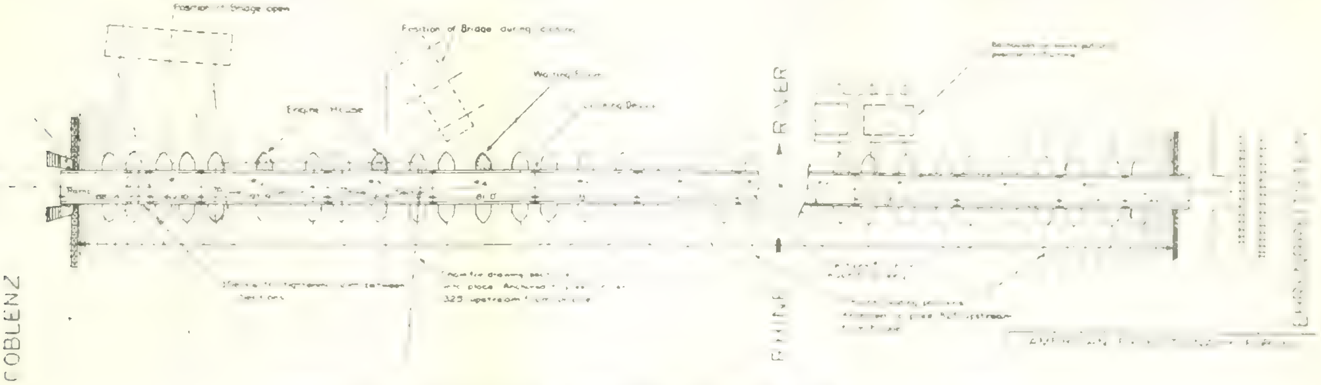
Improved Form of Pontoon Bridge for Public Use

On the River Rhine, at Coblenz and at a number of other places, there is found in public use an improved form of pontoon bridge, which, while common in military operations, has in America, when attempted as a more permanent commercial structure, been usually found very difficult to maintain, and therefore short-lived. An interesting description of this Coblenz bridge is given by Maj. J. W. Skelly, Corps of Engineers, in Professional Memoirs, from which the matter following is abstracted.

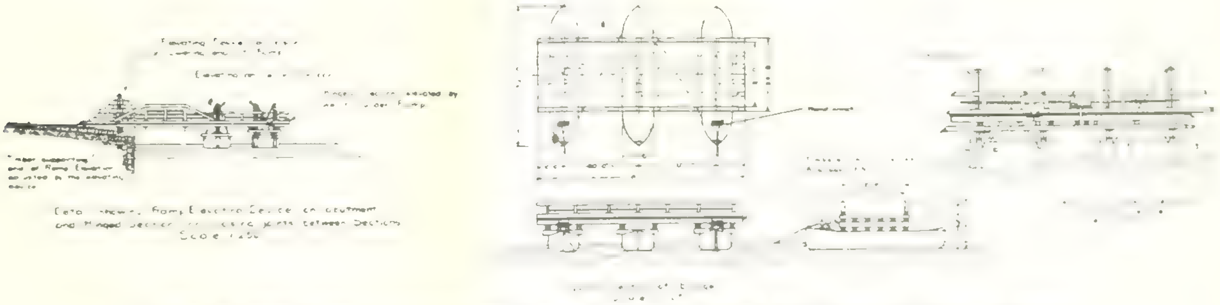
Some of these German bridges are very old, the Coblenz bridge having been built in 1819. The situation on the Rhine is peculiarly favorable, the stream being comparatively narrow, with fair but not excessive depths, and stable bottom and banks. Furthermore there is but little interference from running ice, the average annual period of interruption due to this cause being only 19 days. Drift, which is so common and troublesome on American rivers, is [illegible] is only 8.58 meters (28.1 ft.), between 0.62 meter (extreme low) and 9.20 meters (extreme high). This extreme high stage has been reached but twice in the last 250 years, however and the ordinary annual fluctuations are scarcely 20 ft.

The Coblenz pontoon bridge spans the Rhine about 2,300 ft. above the mouth of the Moselle River, and connects Coblenz on the left bank at a point about 300 ft. above the Rheinstrasse, with Ehrenbreitstein on the right bank, at the foot of Kirchstrasse, being practically a continuation of these streets, which are main thoroughfares. The river at this point is about 1,000 ft. wide

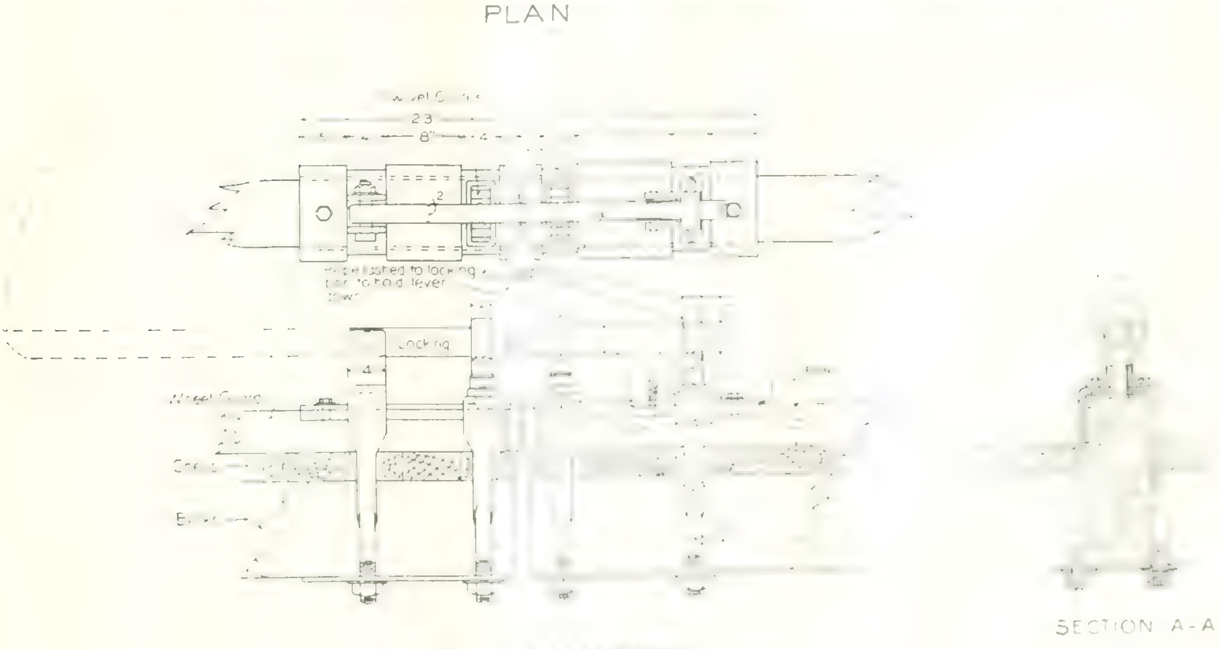
The bridge at ordinary stage is about [illegible] ft. long and is composed of [illegible] sections, two draw sections [illegible] and 81 ft. in length, equipped with steam winches for quick maneuvering, eight regular fixed sections 81 ft. long, and at the ends two short ramp sections about 50 ft. long. Other sections are held in reserve for use as required. Ramp sections and the buttresses on shore are provided with raising and lowering devices for adjusting the height of approaches



General Plan of German Pontoon Bridge Over Rhine River at Coblenz


Detail showing Ramp Elevating Device on abutment and Hinged section ... joints between Sections

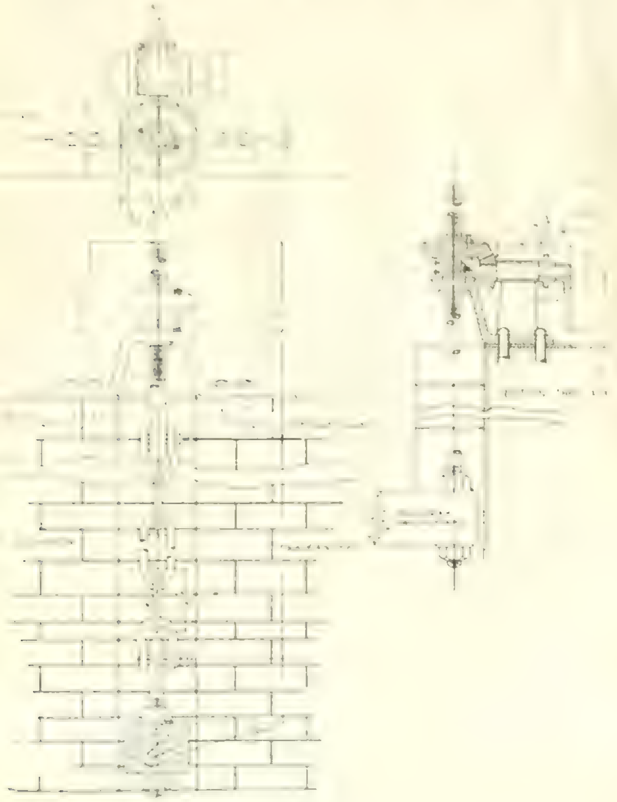
Detail of Ramp Elevating Device and Typical Section of Bridge and Detail of Hinged Section



Locking Device of Pontoon Bridge

to suit the river stage. In summer bath houses are anchored below the pontoons near the right bank.

The pontoons are of iron and were constructed prior to 1877. Originally they were of wood and this type is found at other places. They are small double-end or "model" barges, generally 13 ft. 6 in. beam by 52 ft. length, three pontoons being used with each regular section and usually two to each ramp section. The stringers or balks, six in number, average 8½ in. by 10 in. in section, but these as well as the pontoons are not uniform in size. The planking consists of two 2-in. layers. The clear width of roadway is 21 ft. Each pontoon has in plan, an area of 600 sq. ft. and a net freeboard of about 2 ft., hence the available buoyancy for live load is 37½ tons, though in practice the heaviest load is limited to 15 tons carried on four wheels.

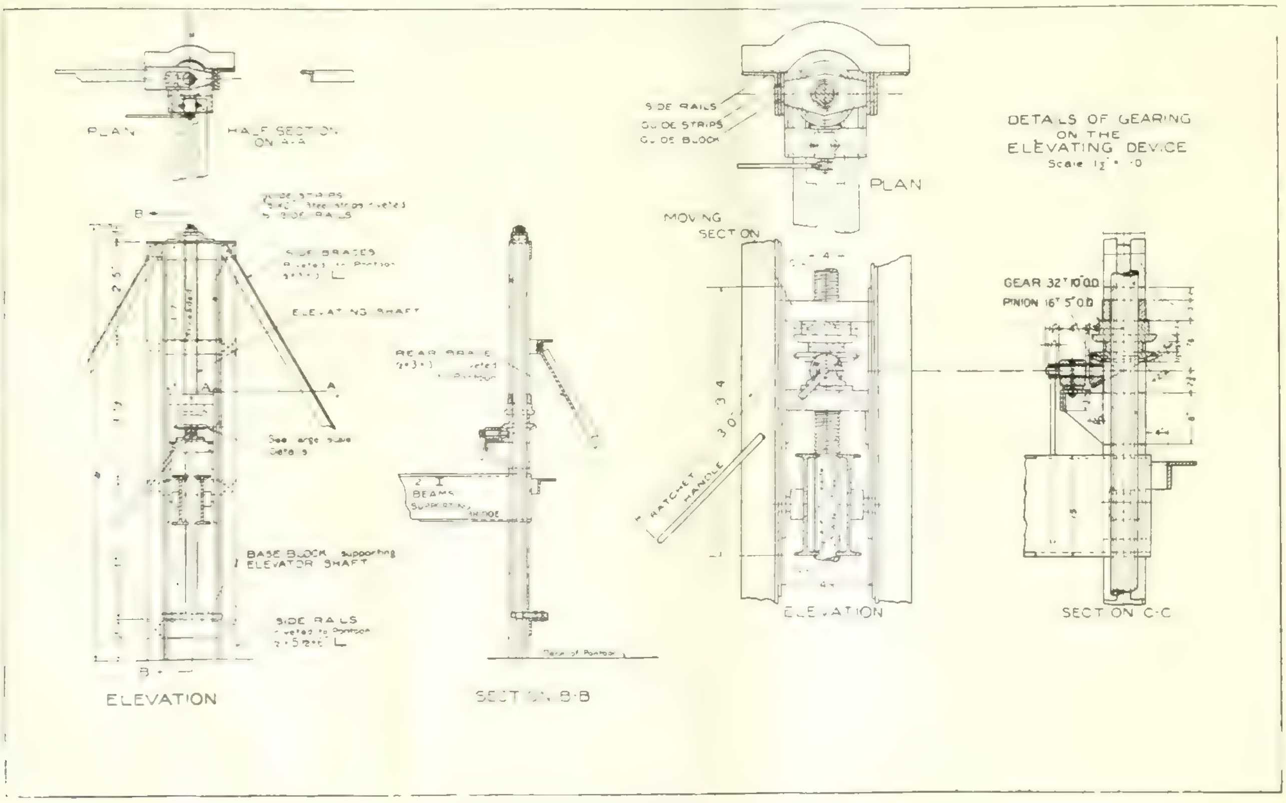


Device for Adjusting Approach to Pontoon Bridge.

The anchorages are piles driven in the river bed in clumps of threes about 300 ft. above the pontoons, their tops projecting but a few feet above the bottom. From these clumps chains lead down-stream to the pontoons, whose position is adjusted by means of hand winches. There is also a cross chain a short distance below the clumps, which forms a continuous line across the river and furnishes a convenient means of locating the anchorages, as it can be readily picked up and followed throughout its length. Its use, however, is only possible here because of the almost entire absence of sediment; otherwise, as for instance in a silt-bearing river like the Mississippi, it would soon be buried beyond recovery. Fixed sections of three pontoons have anchorage chains from the outer pontoons only, the middle pontoon being fastened to the other two.

The two draw sections are maneuvered quite ingeniously as well as expeditiously. To open the draw, guard rails are first lowered across the roadway, the locking devices making the sections fast are next opened and the hinged section lifted, the anchor chains on the draw sections are then payed out, allowing these sections to drop back and clear the fixed pontoons. The chains on the inner pontoons (away from the center of the opening) are payed out more rapidly, which causes the sections to take a skewed position, and acting as rudders they are separated by the current, thus quickly clearing the opening. In closing, this action is reversed, the inner pontoons being hauled up and the outer slacked off, bringing the sections together, when they are hauled into position, the hinged section and locking devices closed, and the bridge is ready for traffic. Recent observations show the average time required for opening or closing the draw to be 2 minutes 20 seconds. The actual time required for maneuvering the pontoons averaged 1 minute 20 seconds downstream and 2 minutes 5 seconds upstream. The periods of interruption to bridge traffic varied according to the nature of the vessels passing, and their direction, from 5 minutes to 21 minutes.

The Coblenz bridge is the property of the Prussian State, represented by the Rhine Construction Administration by which it is maintained, but for operation it is leased to a private concern, which furnishes the personnel, collects tolls, etc. The cost to the State for maintenance during the 20 years, 1896 to 1915, inclusive, was 781,943.59 marks, the average daily cost being therefore 107 marks ($25). The cost of construction is unknown, but even at the present



Details of Elevating Device on Pontoons.

time would be much less than for any other type of bridge of equal capacity. Operation and maintenance charges compare favorably with even a fixed bridge, while in convenience of access there is obviated the necessity for the long and otherwise objectionable approaches of a fixed bridge, and it is in fact preferable in this respect to a draw bridge, of which there are none on the Prussian Rhine.

Daylight and Artificial Lighting of Buildings*

By BASSETT JONES

In factory buildings, office buildings, and the like, lighting, both natural and artificial, becomes of primary importance. The building is useless and bad in design, no matter how much good taste may have been lavished on its structural proportions and decorative features, if suitable and efficient illumination is not always available both by day and by night, and, by day, independently of the sky conditions.

Observation will show that many such buildings are either inadequately lighted or improperly lighted, or both, both by day and by night. In fact, many buildings are better lighted artificially than by natural daylight, because no attention has been given to the proper orientation of windows or skylights, their proper glazing or to proper proportions of windows with relation to the work expected of them.

Apparently, most architects proportion window-area to floor-area by some perfectly arbitrary rule-of-thumb procedure which makes no allowance for the position of the window with relation to the area to be lighted, or to the relation of the window to the primary light-source, which is the sky.

The amount of light received at any point on the area lighted by windows is governed solely by the amount of sky-area that can be seen from this point and the sky brightness, or by the area of luminous surfaces, such as brightly lighted light-colored walls or other area that can be so seen.

If the sky or other equivalent surfaces cannot be seen at points far removed from the windows, then auxiliary devices for reflecting part of the light from the sky must be used at the window to properly distribute the light.

The window thus becomes a light-source and should be treated as such. Unfortunately, it rarely is so treated. In the first place the window is wrongly located. The human eye is not adapted to receive only horizontal light, and, furthermore, it is not fitted for use where the areas of maximum brightness are constantly within the field of vision. When such conditions hold, the eye is under constant strain, and, being thus partially blinded, requires more light than when the maximum light comes from above and the brightest areas are on the ceiling. The result of this condition is that every kind of device from awnings to shades are used to prevent excessive glare and discomfort.

As windows are usually installed and equipped, and where, as is common in city buildings, the sky-zone is much restricted by surrounding structures, by far the larger portion of the light received is thrown on the floor where most of it is absorbed by the dark floor-surfaces. If, in order to conserve the light, the floors were white, or even light-colored, something like snow-blindness would result. When, in addition to dark floors, the walls are dark, the light received at any point is practically restricted to that coming directly from the window, producing sharp and dark shadows, and, in addition, there is little useful light available except closely adjacent to the window. Highlights are sharpened, producing strong brightness contracts, and specular reflection (as from a mirror) is increased, producing glare. Diffusion of light, so necessary to eye-comfort, is lacking.

An ideal window should be equipped with devices which reflect the light entering the window and distribute it over the ceiling, which then should be treated so as to re-reflect the light downward and diffuse it with as little loss as may be. The brightness of the window-area would then be reduced to a point where it would not interfere with the proper functioning of the eye.

Furthermore, the window should be so located and proportioned that the necessary and proper sky-area would be visible from it, in order that the required amount of light would be available. A room equipped in this way is far more comfortable to work in than a room provided with the usual windows, even when shades or awnings are added.

When, in addition to the window equipment suggested above, including highly reflecting and diffusing ceiling finish, the walls are light-tinted with a diffusing coating, the amount of light admitted by the windows may be materially reduced and smaller windows employed, permitting better exterior [illegible] and appearance.

As will be pointed out below, the amount of light required, whether natural or artificial, is controlled by the reflecting character of the interior coatings and the form of light-distribution.

In the course of a recent article on Standardized Distributing Systems (G.-E. Review, Vol. XXI, No. 4, p. 299), the writer drew attention to the effect of wall and ceiling treatment on the efficiency of illumination. In the same place mention was made of the fact that, with proper treatment of interior surfaces, it was possible to find in the room or interior more total light flux than the lamps generate. The same remarks are true of natural daylight admitted by windows, for windows function as lamps function in artificial lighting.

At first glance this statement may seem to the reader inconsistent with some of the most fundamental physical concepts. But any such seeming inconsistency will disappear if we permit ourselves to realize that light is only a form of radiant energy and proceed to consider the parallel problem in heat, namely, an enclosure of variable heat-insulating qualities into which so many thermal units are introduced every second by means of some form of radiator. Obviously, if the insulating qualities of the enclosure are such that no heat can escape, the entire enclosure will continue to rise in temperature until it reaches the temperature of the radiator, after which, if the emission of heat by the radiator is merely a function of temperature differences, and the temperature of the radiator is constant, no further heat can be introduced by this means.

If, now, we proceed to explore the interior surface of the enclosure with an instrument, such as a bolometer that measures incident heat, and if we compare the amount of heat incident on the entire surface with the amount entering through the radiator and call their ratio "utilization factor," we shall reach the conclusion that the utilization is infinitely great, for no heat is entering and a very large amount is incident on the enclosure.

Next, let the insulating qualities of the enclosure be defective. Then the temperature of the interior will rise to a point where the amount of heat [illegible] difference in temperature between the inside and the outside of the enclosure, exactly balances the amount of heat admitted to the enclosure by the radiator. Obviously, the amount of heat emitted by the radiator is a function of the difference between its temperature and that of the enclosure. Thus a balance is established for every possible value of enclosure temperature, this balance occurring when the temperature of the enclosure is such that the amount of heat lost is exactly the amount of heat emitted by the radiator.

Now let us substitute a source of light for the radiator: let us consider luminous radiant energy, and convert the heat-insulation enclosure into one that will reflect more or less of the light incident upon it. If the reflecting value of the enclosure is such that it reflects all the light incident upon it, obviously none can escape, and the amount of light in the enclosure will increase indefinitely because the amount of light present has no effect on the amount emitted by the source.

If the enclosure absorbs some light, then when the total light flux absorbed [illegible] the amount of light [illegible] will [illegible] increase.

It may well be that when this condition of equilibrium is reached, the amount of light-flux incident on the interior surface of the enclosure, only a fraction of which is absorbed, will be many times the amount of light-flux emitted by the source.

The computations of all cases of lighting, both natural and artificial, eventually reduce to just this case, namely, to the problem of determining just how much light flux must be provided by the source [illegible] within it a given amount of flux.

Evidently the light-reflecting character of the surface of the foregoing data determines how much light flux must be generated in order to maintain any desired intensity of light. The method of producing any desired distribution of the light flux over the interior surfaces is another problem. Obviously, those portions of the surfaces on which a large amount of flux is incident should have maximum reflection factors if the amount of light generated is to be kept at a minimum.

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*From the Journal of the American Institute of Architects.

A case was cited in the article above mentioned where the walls and ceiling of a hypothetical interior showed [illegible] per cent reflection factor and the floor but 25 per cent reflection factor. It was shown that the light-flux incident on the floor would be 1.33 times the flux emitted by the light-sources. In the case of the Bloomfield building of the Sprague Works of the General Electric Co., the amount of light-flux incident on the test-plane was 1.04 times the flux generated by the lamps. In the usual Childs' Restaurant approximately 1.5 times the amount of light generated by the lamps can be found on the plane of the table-tops. Therefore, in a Childs' Restaurant, about 80 per cent of the amount of generated light flux used in the Bloomfield building would be required to produce the same incident flux on the table-plane.

Perhaps it is possible to sum up the argument by saying that for every lumen (unit of light quantity) not absorbed, one less lumen need be generated or admitted through the windows.

Every properly designed lighting arrangement must fulfill certain requirements set by the eye, for eye efficiency bears directly upon our value as working organisms, whether we be draftsmen, clerks, or factory hands.

The eye sees brightness,—if, for the present, we do not consider color,—but brightness is merely a visual sensation—a mental phenomenon. The sensation of brightness is aroused by a physical phenomenon, namely, the quantity of light emitted by or reflected from a luminous surface.

Arrangements of lighting that will introduce abnormal sensations, or sensations for which the eye is not adapted, are to be avoided. Marked brightness contrasts produce such sensations. But brightness contrast is a matter of relative values rather than absolute values. A candle in a dark room is blinding, while the most powerful incandescent lamp in a white room is bearable. The design of an optically correct and visually efficient lighting arrangement is more a matter of distribution of light than of its quantity.

From the viewpoint of artificial light distribution, the lighting system does not stop at the fixture. In artificial lighting, as well as in day-lighting, the ceiling and wall-surface in a room, as secondary sources of light-receiving and reflecting light from lamps, are generally of greater importance than the fixtures.

If we aim to avoid objectionable brightness contrast and eye-strain, such as will be produced by a brilliant direct light-surface, the problem of efficient lighting, combined with maximum eye-comfort, is almost wholly a matter of reflecting surfaces. No visible surface in a room, including the window surface, should have a brightness of much more than 2/10 (0.2) candle per square inch, and preferably somewhat less. Furthermore, the maximum brightness contrast must not exceed 100:1. But the reflecting value, or coefficient of reflection, of the ceiling and wall-surface, principally the ceiling-surface, regulates the amount of light that must be left loose, so to speak, in the room to produce the surface brightness required. In other words, the reflecting and diffusing quality of the ceiling and wall-finishes bears directly on the question of energy efficiency.

In an experimental room 13½ by 13½ ft. in plan, with a 14-ft. ceiling height, using one center outlet and incandescent lighting, it has been found ("Illuminating Efficiency," Ward & Harrison, Trans. I. E. S., 1916) that when the walls showed a coefficient of reflection of 42.5 per cent, changing the coefficient of reflection of the ceiling from 50 to 80 per cent increased the illumination on an arbitrary plan 3 feet above the floor 68 per cent. Tests on various arrangements of the room, both in dimensions and outlets, gave comparative values. These values compare well with the measurements made by Sharp and Millar and by Rolph.

Similar tests carried on by the writer under working conditions in many rooms, tinted in different ways and lighted by properly designed semi-indirect fixtures, leads him to believe that, generally speaking, where wall-finishes show a coefficient of reflection of 50 per cent, changing the coefficient of reflection of the ceiling from 50 to 80 per cent will increase the working illumination 50 per cent.

These observations show that we are dependent on the ceiling for most of our light about 60 per cent of it where the ceilings are light and the walls slightly tinted. But we do not want to see images of the lamps in the ceiling, for glare is introduced with its attendant eye-strain, so a flat finish is almost essential. We wish to lose as little of the light as may be, so a dense surface is required—dense, so that the light cannot get into the surface and thus be absorbed; and white, because tinting markedly reduces its reflecting value.

If due allowances are made for dirt accumulations, aging, etc., and for the fact that paints having 80 per cent reflection coefficient are not generally obtainable, we may safely say that the differences between well-painted white ceilings and ordinary light buff ceilings amount to between 20 and 30 per cent of the illumination. This is conservative. With the proper selection of paint, proper application, and proper preparation, these values may be increased.

From what has now been said, it must be obvious that with properly designed, glazed, and equipped windows, and when the interior surfaces are properly treated, it should be possible to provide artificial lighting whose quality, distribution, and intensity are closely similar to the natural day-lighting. The two can be made to work together so as to produce practically the same results. One can be used to reinforce or replace the other without establishing an entirely new set of conditions to which the eye must adapt itself—often resulting in strain that if maintained is a source of permanent injury.

Today's and Pre War Costs of Small House

A dwelling which before the war cost $2,500 now costs $3,747, according to data given by A. W. Smith, Architect, Oakland, Calif., in the Architect and Engineer. The figures cited by Mr Smith are based on actual contracts let by him, and were compiled early in February. They are as follows:

LABOR COSTS ON A DWELLING WHICH BEFORE THE WAR COST $2,500

	No. of days	Before war rate.	Amount.	Present rate.	Amount.
Carpenter labor	70	$5.50	$ 385.00	$7.00	$ 490
Plastering labor	21	6.00	126.00	9.00	189
Plumbing labor	5½	6.00	33.00	8.00	44
Painting labor	32	5.00	160.00	7.00	224
Hodcarrier labor	7	5.00	35.00	7.00	49
Cement workers' labor	6	4.50	27.00	6.00	36
Cement finishers' labor	2	6.00	12.00	8.00	16
Lathers' labor	8	6.00	48.00	8.00	64
Brick labor	1½	7.00	10.50	8.00	12
Electricians' labor	2½	6.00	15.00	8.00	20
Sheetmetal labor	1½	6.00	9.00	8.00	12
Roofing labor	3	5.00	15.00	7.00	21
Patent chimney labor	½	6.00	3.00	8.00	4
Shade hanging labor	½	5.00	2.50	6.00	3
Fixture hanging labor	1½	5.00	7.50	6.00	9
Mantel labor	1½	7.00	10.50	8.00	12
Sewer work labor	2	3.50	7.00	5.00	10
Mill work labor	25	5.00	125.00	6.00	150
	189	Av. $5.53	$1,031.00	Av. $7.22	$1,368

The increase in labor cost of $337 is an increase of nearly 33 per cent.

COSTS OF MATERIALS AND SUB-CONTRACTS, LESS LABOR COSTS ABOVE, ON A DWELLING WHICH BEFORE THE WAR COST $2,500.

	Before war cost.	Present cost.
Plastering and [illegible]	$ 185	$ 220.00
Painting and [illegible]	66	105.00
Plumbing	142	205.00
Brick and mortar	53	65.00
Lumber	306	625.00
Sash, doors, and other mill work	193	340.00
Hardware [illegible]	63	90.00
Sewer	13	25.00
Electric	21	56.00
Mantel	21	27.00
Shades	14	23.00
Fixtures	31	56.00
Walks and [illegible]	41	55.00
Roofing	38	54.00
Sheet metal	9	22.00
Patent chimney	10	23.00
Workmen's compensation insurance (3½ per cent)	36	47.85
Total	$1,242	$2,038.85
Add labor	1,031	1,368.00
	$2,273	$3,406.85
Add 10 per cent for contractors' profit and miscellaneous expenses	227	340.68
Cost	$2,500	$3,747.53

Percentage of increase of material is 64 per cent.

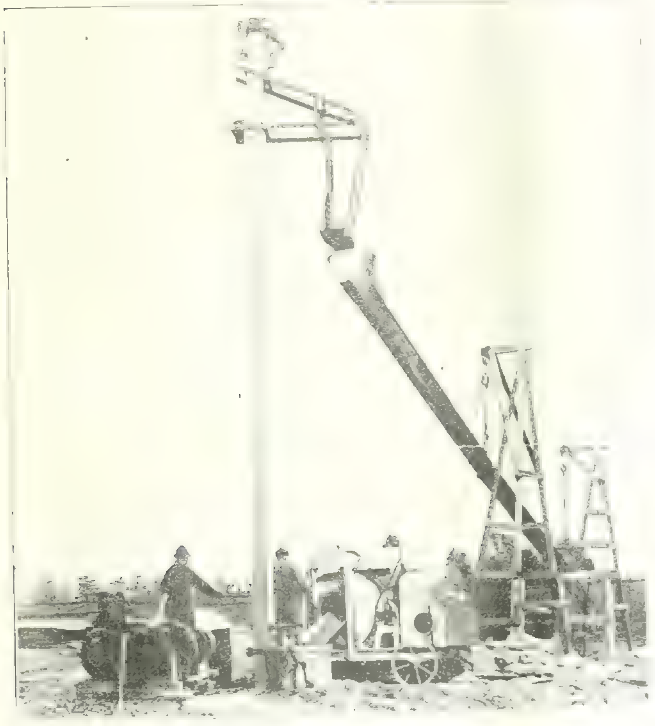
The increased cost of labor and materials is 50 per cent.

Concreting Plant for Small Yardage Jobs

A concrete distributing plant operating on the principle of the standard tower equipment, but designed especially for use in connection with the construction of structures containing small yardages, has been developed by the Insley Manufacturing Co., Indianapolis, Ind.

The plant consists of a 7-cu. ft. capacity hoist bucket, a mast on which the bucket runs, a head frame which automatically dumps the bucket and provides a support for a chute, where chutes are used, sheaves to take the hoist line, manila rope lines for guying the mast, a ⅝-in. wire rope hoist line, a small single drum hoist and such chute sections as can be used to advantage together with the tripods or gin pole that may be required for their support.

The hoist bucket is made in one size having a capacity of 7 cu. ft. of mixed concrete, thus being suited for use with either a ½ or 1-bag mixer. A bail is provided for the hoist line and the discharge of the load of concrete is controlled by a radial gate and movable apron which are actuated by a system of toggle levers. A frame built out from the back of the bucket and carrying four guide rollers grips the mast and provides the necessary guiding medium.



[illegible] Hoist Bucket Plant, Showing Bucket Being Charged at Mixer

The mast, which is of wood and built up by the contractor on the job, has a section 10¾ in. by 11½ in. Its height will depend upon the work in connection with which the plant is to be used, the maximum practicable height being between 40 and 50 ft. owing to the fact that but one set of top guys is used for its support. In figuring the height of the mast which will be required where the concrete is to be elevated and carried away by carts it is only necessary to add 10 ft. to the maximum height to which the concrete is to be hoisted. Where chutes are to be used for conveying concrete away from the hoist bucket it is necessary to take the maximum height of the work, allow 10 ft. for head room and to this sum add one-third of the horizontal distance through which the concrete is to be chuted, this last factor taking care of the commonly accepted 1 in 3 slope of the chute line.

The head frame has integral with it a small hopper which serves to guide the concrete from the hoist bucket to the chute, where chutes are used, or direct into carts where the concrete is wheeled away. This head frame is so clamped to the mast that it can readily be raised or lowered and serves two functions, the first being to provide a stop which automatically dumps the bucket and the second to furnish a chute support.

The hoist is carried on two 8-in. sheaves which are supported by suitable brackets, the mast being slotted out to provide an opening for the line. For the hoisting any standard single drum hoist of between 6 and 8 HP. is required, the larger power being recommended. The weight of the bucket and its load is approximately 1,300 lb.

In operating the plant, the mast is set up at a central point and a slight depression is made in the ground at the mast foot in order to permit of the bucket being lowered sufficiently so that the concrete can be dumped directly into the bucket from the mixer. The overall height of the bucket is 25 in., from which it can be seen that this depression is relatively slight. After receiving its load from the mixer the bucket is hoisted and automatically dumped upon reaching the head frame, one lever first striking the head frame and throwing out the apron which bridges the distance between the bucket gate and the head frame hopper, and another lever striking the head frame an instant later thus opening the bucket gate. The shape of the bucket is such that it cleanly discharges its load by gravity. As soon as the load is discharged the hoist line is slackened, the bucket gate first closing and the apron immediately afterward returning to its normal position. The plant will easily take care of all the concrete a one-bag machine can mix.

Government Monuments and Their Recovery

Interesting information on the construction of the original monuments in the prairie country and the methods for their recovery was given by Mr. Robert Harvey, State Surveyor of Nebraska, in a paper presented at the recent Nebraska Road Institute. An abstract of the paper follows:

Government surveyors were supposed to use for corner monuments the best material afforded by the country in which they operated. These materials were classified according to their durable qualities, stone standing at the head of the list in durability.

In those parts of the open prairie country destitute of timber and devoid of stone, resort was had to other means to perpetuate the corners. The law provided that a wooden post should be set with a deposit of charcoal or other memorial, surrounded by a quadrangular trench 1 ft. wide and 1 ft. deep, with a pit 2 ft. long by 2½ ft. wide dug 18 in. from the outer edge of the four sides of the trench and the earth therefrom piled in conical formation about the post. In course of a few years [illegible] by the action of the [illegible] off at the surface, leaving the point of the post to decay in the ground. In lieu of a charcoal deposit or charred stake for a memorial, many of the deputy surveyors sharpened and burned the end of the posts, enough for each day's work. If the posts were not knocked down by wild beasts or pulled out by Indians or white men these points remained in the ground, performing the function of charred stake. This was considered by the government as a virtual compliance with the law, [illegible] a great [illegible]

June 1, 1864, the "trench" was abandoned and in 1867 or 1868 only two of the four pits at ¼ section corners were required to be dug, and in July, 1873, an order was issued by the department that in regions where neither wood nor stone abounded the surveyor [illegible] stake 2 in. by 2 ft. long in certain witness pits, and afterwards the order was made to cover grazing regions which was a wise provision for mounds and posts standing 3 or 4 ft. above ground, would not last an hour when attacked by cattle.

The "trenches" and pits were left open, and in the course of years the ashes from the burned grass, dust, sand and decayed vegetation were blown into them, gradually filling them so that in time there is often no visible surface indications whatever of either mound trench or pits.

The time, labor and money spent by the original surveyor centered in the establishment of the corner, so now all the time spent in retracement by the later surveyor culminates [illegible]

5 ft. square or a parallelogram 4 or 5 in. wide by 7 or 8 in. being filled with crowded earth; there may be in it the evidence of a circle of lighter colored soil where the post stood several stakes may be found in various stages of decay. If the surveyor detects a round spot of the dust of decayed wood, perhaps filled with grass roots, it will be a pretty safe conclusion that it is the original corner, even should no memorial of charcoal of charred stake be found; but this should not be relied upon as a complete identification. Search should be made for evidences of the original "trench" if (East of the 6th P. M.) and for the witness pits which will in general be evidenced by the dark colored deposit caused by the black ashes, generally in the form of a square, 4, 5, or 6 ft. N. E., S. E., S. W. and N. W. directions at section corners, and about the same distance at ¼ section corners N., S., E. and W., if dug before 1867. In 1867 they were probably dug on the section line but after that they were mostly dug across the line. This was another great mistake, as they were then very liable to be easily destroyed by highway traffic and by cultivation along the fences. In 1890 the order was reversed, when Nebraska surveys were mostly completed however in Boyd county and that part of Keya Paha north of the Keya Paha River and pits at ¼ section corners were dug on the line.

In sandhill regions the witness pits will in all probability be filled with light gray colored sand excepting in valleys where there has been rank growths of grass and where the winds have a fair sweep in carrying the black ashes.

In regions destitute of timber and devoid of stone which was the grazing country, corners may be destitute of memorials, especially if the notes do not mention it, and some of the deputies did not deposit a memorial, notwithstanding their mention in the notes, but they should be looked for and the pit examined to see if the decayed remnants of the stake can be found.

If the conditions are favorable a plow with a clean, sharp share can be used to turn over 2, 3, or 4 in. of the original surface, the bottom of the furrows being turned with sharp spades. The plows sometimes may be used to entirely remove the turned-over soil to expose the entire space.

In using a plow care should be taken not to plow too deep; from 2 to 5 in. is deep enough in the original soil.

The trench and witness pits were very seldom dug more than 1 ft. deep and 18 to 24 in. square. Very often they were not more than 6 to 8 in. deep.

The exact situs of the original corners should be first determined. If the roadway has been graded up, the fill should be removed until the surface of the original soil is laid bare from a sufficient space so as to include all the marks of the original surveyor; this may require the uncovering of considerable space, 10, 20 or more feet, and sometimes extending the search to what might be considered an unreasonable distance.

Along lines where corners were of stone, without the trench or witness pits, it is no unusual thing to find that the stone has been knocked out by accident and reset as near the same place as was known, or moved by design. The problem then is to find the place where the stone originally stood. This may be done by shaving the surface with clean, sharp spades to discover a spot of different colored earth approximating the breadth and thickness of the stone; by the solidity and texture of the filled-in deposit, by small spalls or particles of the stone which the action of freezing and thawing has loosened, or by fine stone dust caused by the wear of traffic or rubbing of the iron tires against their sides. The deposit in the hole 40 years old will have in general a different color, texture and solidity than one of 20 years, or of a more recent date.

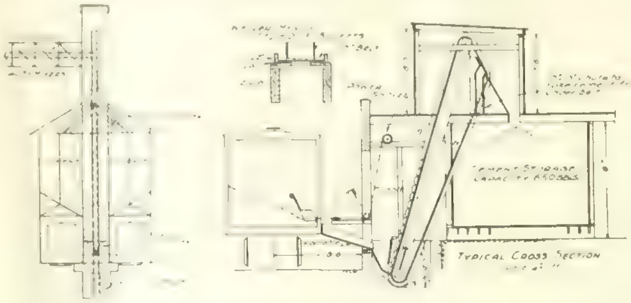
It is no unusual thing to find that surveyors when unable to readily find the corner stone, set another by measuring from the corner of an old fence or the mean distance between the corners of opposite fences; it then becomes a delicate question as to which is the original. The description given in the notes of the original surveyor should be consulted to compare the kind of stone, length, breadth and thickness and sometimes the color. The position of the fences and their age and what was the idea of the ancient settler in planting his hedges or rows of trees, and reputation for carefulness, also should be considered.

Many surveyors seem to have the idea that charcoal or some other memorial was placed in the pits by the government surveyors and are never satisfied until they have pared and shaved off the soil or dug to the bottom, thus destroying them. The surveyors did not put anything in the pits, but left them open to assist the landseekers in finding their locations; the elements filled them in after years. No surveyor would for a moment think of destroying a witness tree after he had found it, by cutting it down and grubbing out the stump. The witness pits are more valuable than witness trees, for if left undisturbed they can be identified after thousands of years; they are good for all time. Therefore, the surveyor should leave undisturbed as much of the original deposit as possible for other surveyors in the future, perhaps hundreds of years hence, may need the evidence of those pits made in our generation.

$50,000 Plant for Handling Bulk Cement for Construction Job

In connection with the construction of the Tennessee River dam at Alcoa, Tenn., the $50,000 plant has been erected for receiving, storing and handling bulk cement. On this work about 500,000 bbl. of cement will be used. The plant for handling this cement was described by Mr. Wallace R. Harris, Engineer of the Cement Products Bureau of the Portland Cement Association, in a paper presented before the Western Society of Engineers. The notes that follow are abstracted from this paper.

The plant (see Fig. 1) is so constructed that two receiving tracks are provided, thus allowing the unloading of two cars of cement simultaneously. The unloading is done by power shovels. The cement is unloaded into the receiving hopper of a bucket elevator which deposits the cement into receiving chutes and also into a screw conveyor which distributes part of the cement to other receiving chutes. This arrangement allows the bulk cement to be evenly distributed throughout the storage bins. By using a deflector at the discharge chute of the bucket elevator, the cement can be deposited into another screw conveyor leading to the concrete mixing plant. This arrangement permits cement being taken directly from the cars and conveyed to the storage bins at the concrete mixing plant without storing in the main storage bin.



Cross Section of Plant and Arrangement of Power Shovel Used to Unload Bulk Cement.

When, however, it is desired to take cement from the main storage building, delivery chutes are opened in the bottom of the central storage space. The cement flows into a screw conveyor and is carried to the bucket elevator, raised to and deposited into the screw conveyor leading to the concrete mixing plant.

Portland cement becomes firmly compacted when the entrapped air is released and a reduction in volume equal to as much as 25 per cent will occur. As the slope of the hopper bottoms of the storage bins is not sufficient to overcome the arching action of the cement, means must be taken to break up the arching and to cause the cement to flow easily. The compacted mass of cement can be converted to an almost fluid condition by the introduction of air under pressure, and this can be accomplished by placing air pipe lines ½ in. in diameter, on 24-in. centers, the lines being laid on the hopper bottoms of the bins and also on the bottom of the central storage space in which the delivery chutes are located. These air lines are provided with 1/32-in. openings on 6-in. centers and each line is encased in a sheath of four-ounce canvas sewed in the form of a tube. This canvas sheath is wired to the ½-in. pipe by wire tires placed on 6-in. centers midway between the 1/32-in. outlets. An air pressure of 80 lb. at the compressor would be found sufficient to create a flowing condition in the cement.

The cement is contained in a temporary bin of comparatively small capacity at the concrete mixing plant. This bin is provided with delivery chutes for each one of six 2-yd mixers, the machines being arranged in two batteries of three mixtures each.

The Engineer in Politics*

By W. A. STINCHCOMB,
County Engineer of Cuyahoga County [illegible]

Let me make myself clear in the use of the word "politics." I do not refer to it in its partisan sense, but I do most decidedly refer to it in a civic or governmental sense.

To say that the American Association of Engineers and its members shall not go into politics would be to deny to the country and the local communities within which it has chapters the service of an organization of men who, by natural ability, by education, by training and by experience are most capable of serving the public and in directing and educating the voters on questions of public policy, and would deny to its members the fulfillment of their obligations as citizens of this Republic.

Now I know that a natural tendency exists among engineers not to take an active part in politics, but by so doing they evade their full responsibilities as citizens. In my opinion a man's responsibilities to his city, his state and his country increase just as his abilities and opportunities increase.

Shall any one say that the engineer's training and experience does not better fit him to solve the problems of government as our civilization becomes more complex, than one trained in any of the other great professions?

Some of the Political Problems.—In our cities practically all of our public problems are subject to scientific analyses. Is the subject one of developing the physical plant of the city, including the adequacy and location of its highways, the kind and strength of its pavements, the development of its park and recreation facilities, the working out of a proper drainage or the planning of its transportation facilities, either rail or water? Surely the engineer is best qualified to solve such problems. He is now called on for advice in these matters, and in my opinion he should be the one to largely decide.

In matters of public health as influenced by problems of sanitation such as sewage and garbage disposal, water supply and building and housing regulations, he is best qualified.

Even in the welfare and social problems of the city his analytical training fits him to search out the cause of our social evils and ills—to relieve them rather than apply only palliative and preventive measures.

Shall any one say that he is less qualified to organize and direct the ordinary housekeeping affairs of a city because of his training and experience?

One of the most difficult and always present problems of all government is that of financing and taxation. It is the constant duty of the engineer in his practice to so design, execute and organize his work so that in terms of unit cost that cost shall be as low as possible. All problems of public taxation must go back to a proper appraisal of the property taxed whether that property be in a tangible or intangible form. Here again his experience and training fit him well to efficiently serve.

So we might analyze the many problems of state government, such as the development of a system of highways commensurate with the traffic needs of the day, the regulation and control of public utilities, the development of water transportation, the industrial and social problems affecting the workers in mines and factories, the care of the wards of the state, the development of its educational system, and the conservation and development of its natural resources. In all of these we find his training and experience should particularly fit him to serve.

Our national governmental problems are best solved when the engineering mind influences their solution.

And so in my opinion the engineer should take a dominant part in politics, and this association as an organization should wield a forcible influence in determining the civic and governmental policies—not as a right only, but as an obligation which both the engineer and the association owe to society.

Political Activity Beneficial to the Association.—[illegible] hear some timid soul say, "what effect will that action have on the engineer and this association?" In my opinion it cannot be anything but beneficial.

This convention has had its attention called to the inadequacy of the salaries paid engineers in public service. Various means will be discussed as to methods by which salaries may be properly and equitably increased. How better can this be done than that the members of this profession shall take an active interest in the political questions of their communities?

We have noted the appointment of men neither fitted by education or training to take charge of departments of public service which really require the services of the trained engineer. We have seen the engineer subordinated to such superiors. He has seemingly been content to let his "light shine under a bushel," and have the accomplishments of his brain and energy appropriated by those to whom they do not rightly belong. By a more active participation in politics these injustices would be removed and credit bestowed where it rightfully belongs.

We have seen national organizations of other professions jealously guarding the business interests of the members of their professions. There is the National Bar Association, the various national organizations of the medical fraternity, whose efforts are used not only in maintaining a proper code of ethics in the profession, but in seeing that the members of that profession as a body are not discriminated against by the passage or operation of what they consider to be unjust laws. And so in halls of legislatures their representatives are seen when measures affecting those professions are under discussion and the professions referred to do not have to do with the public work of the state in any degree compared with that of the engineer.

It has always seemed to me that the engineer himself has been to blame for the position in which he is held by society and for the meagerness of the salaries paid by both public and private corporations for his services. He has been retiring in his nature, content to too large a degree to take his reward from the satisfaction growing out of difficult problems well solved and difficult work well performed.

I recognize the fact that there are certain kinds of professional advertising which are distasteful, but I know that you cannot expect to have the public place a proper estimate on the value of a profession unless that profession itself as an organized unit holds it up to a high standard of value. This [illegible] gence by the engineer in the political problems and discussions of the day.

We cannot in a democracy expect to maintain our government for any length of time in advance of the intelligence of the voters. The intelligence of the voter is only expressed through the polls and is influenced by the kind of political education which the voter received. In elevating the standard of citizenship the engineer can and should be a leader in his community. To be anything less not only results generally to the disadvantage of the individual but decidedly to the disadvantage of his profession, and is a direct evasion of the responsibilities of citizenship which his training and ability impose upon him.

Therefore, in my opinion the members of this organization and the organization itself should take an active part in politics in the sense in which the word has been used.

They and it should become leaders in moulding public opinion in a manner free from partisan political bias.

Individualism

The cure for Socialism is Individualism. American individualism has made this country great and its citizens prosperous. The development of the individual and the preservation of his individualism is the real task of democracy. American individualism received its test in the world war. The principle of equal opportunity and equal obligation, of individual development, proved its superiority in a score of notable ways and in none more signally than on the battle fields of Northern France and Belgium.

Let us take up systematically as we never have done before [illegible] of it a sound and practical economic and political creed, and let this be frankly in opposition to the teachings of socialism. [illegible]

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*From an address delivered at the last annual meeting of the American Association of Engineers. Mr. Stinchcomb [illegible] date for Mayor of Cleveland, O., at the last [illegible].

[illegible] let the [illegible] without any [illegible] of [illegible] on the part of Americans.

Let us have forcible, affirmative, clean-cut teaching of the American principles of [illegible], of equal opportunity, of equal obligations, of self-help. Especially let none but Americans [illegible] in our schools and colleges. Americans who not only give formal allegiance to the republic but who believe in genuine Americanism in order that our boys and girls may grow up in an atmosphere of American individualism.

Individualism, initiative, self-discipline, voluntary self-repression for the public good, alert and wholesome co-operation, these are the things to be encouraged and cultivated with all the enthusiasm and power and unselfishness that we can muster. In such a sane and forward-looking atmosphere socialism and all other inimical and un-American isms will be smothered.—The Valve World.

Rules for Piling Lumber

Sawed lumber generally is dried by being piled in stacks with air spaces between the boards. In forming the stacks the boards usually are laid flat, with strips called stickers between courses or layers. A space also is left between each board in layer and the adjacent board to provide for the circulation of air throughout the stack. Flat or horizontal piling may be of two kinds: (a) With the ends of the boards toward the alley—endwise piling, and (b) with the sides toward the alley—sidewise piling. Figures 13 and 14 illustrate the two methods. The stacks are arranged to slope from front to rear, and to lean forward so that water dripping from the top falls to the ground without trickling down over the courses below. With either method of piling the stacks should be so located in the yard that the prevailing winds blow through them rather than against the ends. Most lumber manufacturers and dealers use the endwise method of piling. Useful suggestions for piling lumber, covering the more important points to be observed in the construction of foundations, shape of stack, arrangement of stickers, etc., are given as follows, by Mr. Harold S. Betts, in Bulletin No. 552, a professional paper of the U. S. Forest Service.

Foundations (Endwise or Sidewise Piling): (a) The foundations should be strong, solid and durable.

(b) The top of each foundation should be level and from front to back the top surface of the parallel skids should be in alignment, so that the lumber to be piled will bear equally upon each one.

(c) The front foundation should be raised above the second, and the second above the third, to allow a slant in the stack of 1 in. to every foot.

(d) The foundations should be spaced not over 4 ft. apart, except for heavy planks and timbers.

(e) The front foundation should be of sufficient height to provide space for free circulation of air under all parts of the pile.

Lumber (Endwise Piling): (a) Skids, preferably 2 by 4 in., should be laid on top of the foundations.

(b) Boards of equal length should be piled together.

(c) The ends of the boards should rest upon the front and rear skids.

(d) A space of approximately ¾ in. should be left between boards in the same layer.

(e) Lumber piled in the open should have the front ends of boards in each layer slightly protruding beyond the end of the layer beneath, to give a forward pitch to the stack.

Lumber (Sidewise Piling): (a) Skids, preferably 4 by 6 in., should be placed across the foundations at about 4-ft. intervals. The number of skids depends upon the thickness of the lumber.

(b) Boards of equal length should be piled together.

(c) The boards should be placed on the skids, with about ¾ in. between boards in the same layer.

(d) Lumber piled in the open should have the front board in each layer project slightly beyond the board in the layer beneath, to provide a forward pitch to the stack.

Stickers (Endwise or Sidewise Piling): (a) Stickers should be of uniform thickness, preferably ⅞ in. for 1-in. lumber and 1½ in. for 2-in. lumber. Their length should be a few inches in excess of the width of the pile.

(b) Stickers should be placed upon the layer of boards immediately over the skids and kept in alignment parallel to the front of the piles.

(c) The front and rear stickers should be flush with, or protrude beyond, the ends of the boards.

Roof Protection (Endwise or Sidewise Piling): Cover boards, as a roof protection, should be laid on the top of the pile, extending a few inches beyond the front and rear ends of the stack.

Spacing Stacks (Endwise or Sidewise Piling): Space between the piles should not be less than 2 ft.; 4 or 5 ft. is preferred if yardage conditions permit.

Dimensions of Stack (Endwise or Sidewise Piling): The customary width of stacks is from 8 to 16 ft. The height is governed by the size and character of the lumber and by the methods of [illegible].

Treated Ends (Endwise or Sidewise Piling): The ends of lumber 2½ in. thick, or over, unless of the lower grades, should receive a brush treatment of paint or some liquid filler.

These rules are based on information obtained through field investigations and from lumber manufacturers and wholesale and retail dealers, and accord with the best lumber-piling practice in general commercial use. Certain species of wood, however, require particular care in airdrying, and in this case slight variations from the rules are necessary in order to secure the best results. Some lumbermen in the South, for example, find that thick red oak checks badly on the ends, and in air-drying such stock have adopted the scheme of protecting it with sun shields, which they claim reduces endchecking to a minimum.

Mills cutting red gum formerly experienced difficulty in drying the lumber, on account of its tendency to warp. This objection, however, has been largely overcome by the exercise of care in seasoning. In erecting a pile of gum lumber, stickers are placed every 2 ft. apart, some lumbermen claiming that 18 in. is none too close to obtain the best results. Another scheme in more or less general use among gum-lumber manufacturers is to construct the pile so as to have a flue or "chimney" in its center, thus providing ample air circulation vertically through the stack.

Green cottonwood, basswood, and yellow poplar lumber is likely to stain badly when piled. Accordingly, a number of lumbermen either end-dry the material or pole-dry it for a week or two and then place it in a "stuck" pile. In end-drying, the boards are stood up on end, edge to edge, under a specially built shed, with stickers arranged horizontally one above the other at specified distances. Such a pile presents exactly the appearance of a regular lengthwise pile of lumber set up on end.

Cost of Creosoting Car Sills and Roofing.—The average cost of the creosote treatment for car sills at the plant of the Marsh Refrigerator Service Co., Milwaukee, Wis., is estimated to be $4.50 per 5 in. x 8 in. x 35 ft. sill. Of the total $4 is for creosote oil, 10 lb. per cu. ft., for 9.7 cu ft., or 10.8 gal., and 50 ct. is for labor and overhead. The average cost per M ft. B. M. is $38.54. In treating the subflooring and roofing two men handle approximately 400 pieces per hour, making the labor cost per piece $.0005. Overhead is estimated at $.0005 and the cost of creosote oil at 8 lb. per sq. ft. of surface makes a total cost per piece of about $.018 or $10.65 per M. ft., B. M.

Personals

George With[illegible] has been appointed city engineer of Joliet, Ill.

W. J. Ovatt has been appointed city manager of Villisca, Ia.

John Lindros has been appointed building inspector for the city of Rock Island.

David Carlson, Jr., has been appointed building inspector for the city of Rockford.

William R. Jordan, formerly harbormaster of Erie, Pa., has been appointed a member of the city planning commission.

Charles Joseph Tilden, professor of civil engineering at Johns Hopkins University, has been elected professor of engineering mechanics in Yale University and assigned to the Sheffield Scientific School.

Industrial Notes

The National Tube Co., Pittsburgh, Pa., has made arrangements with the National Metal Molding Co., of Pittsburgh, and the American Circular Loom Co., of New York, to act as its distributors of spellerized mild steel tubing, made especially for the manufacture of rigid steel conduits.

All manufacturing and selling interests in Bloxonend flooring of the C. J. Carter Lumber Co., Kansas City, Mo., Doniphan Lumber Co., Kensett, Ark., and Marsh & Truman Lumber Co., Chicago, Ill., have been merged into a single corporation, the Carter Bloxonend Flooring Co., with home office in Kansas City, manufacturing plant at Kensett, Ark., and sales office at 1601 McCormick Bldg., 332 South Michigan Ave., Chicago, Ill. The individual lumber business of each of these will be conducted under the old names as heretofore.

Author Vol. 51, Jan-June/19 153647
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